PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

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VOL. XIX. MARCH TO DECEMBER, 1880. No. 107.

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EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the

PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA.

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Stated Meeting, March 19, 1880.

Present, 8 members.

Visitor, Mr Hampton L. Carson of Philadelphia.

Letters of envoy were received from the Central Physical Observatory at St. Petersburg, January, 1880; from the Royal Observatory at Greenwich, February, 1880, and from the Meteorological Society in London, February, 1880.

Donations for the Library were reported as received from the Asiatic Soc., Yokohama; Russian Academy; Botanische Central-blatt, Leipsig; Deutsche Rundshau für Geog. u. Stat., Munich; Belgian Academy; Geographical Societies at Paris and Bordeaux; the Revue Politique; Revista Euskara, Pamplona; British Association; Society of Antiquaries; Meteorological Council of the Royal Society, London; Natural History Society, Montreal; Museum of Comp. Zoöl. Cambridge, Mass.; Franklin Institute, Medical News, Dr. Alfred Stillé, Dr. C. P. Krauth, and Mr. Henry Phillips, Jr. of Philadelphia; Smithsonian Institution; Bureau of

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Education; Engineer Department, Washington; Ministerio de Fomento, Mexico; and Prof. S. S. Haldeman.

Donation for the Cabinet.—Mr. Hampton L. Carson presented, on the part of his sisters and himself, in fulfillment of his father's wishes, to the cabinet of the Society, a portrait in oils of M. François André Michaux, the botanist, who died at Paris, October 23d, 1855, ætat 85.

Mr. Fraley returned the thanks of the Society for so interesting and valuable a relic of our distinguished fellow-member, who exhibited in his lifetime so great an attachment for the Society, and in his will such confidence in the honor of its traditions as to make it the trustee of a fund which he bequeathed for Silviculture in America.

Mr. E. K. Price also described the amicable relations which existed between M. Michaux and the Society, claiming the privilege of doing so on the ground that the Society had conferred on him the duty of carrying out the designs of M. Michaux according to the plan adopted by the Committee and approved by the Society, and sketched the principal features of that plan—the planting of the Michaux grove—and the organization of Prof. Rothrock's annual course of public lectures in the Park.

It was then on motion

Resolved, That the thanks of the Society be presented to Mr. Hampton L. Carson and his sisters for their gift of the portrait of M. F. A. Michaux whose liberal bequest to the Society is now so beneficially available for the promotion of Silviculture and Botany.

Resolved, That the Society appreciates the gift more highly because it has been made in compliance with the wish of the late Dr. Joseph Carson, one of its devoted and useful members, whose memory is endeared to his associates by many recollections of his worth and virtues.

Resolved, That a copy of these resolutions be transmitted to Mr. Carson.

The death of Dr. William Theodore Roepper, at his residence in Bethlehem, Pa., on Wednesday, March 10th, at the age of 70, was announced by Mr. Lesley.

On motion, Dr. F. A. Genth was appointed to prepare an obituary notice of the deceased.

The death of General Hector Tyndale, at his residence in

Clinton street, Philadelphia, on Friday, March 19th (3 A. M.), at the age of 58, was announced by Mr. J. S. Price.

A communication was received entitled "Nodal estimate of the velocity of Light," by P. E. Chase.

Mr. Phillips read a paper describing two very old and curious maps of North and South America.

Dr. Greene communicated a paper "On the action of hydrochloric acid and chlorine on acetobenzoic anhydride," by Wm. H. Greene, M.D.

Pending nominations Nos. 893 to 901, and new nominations Nos. 902 to 908, were read.

The publication of the proceedings at the late celebration of the Centennial Anniversary of the Incorporation of the Society was then discussed.

The Committee on the Michaux Legacy reported through its chairman, Mr. E. K. Price:

"That the appropriation made last year was applied to defray the expenses of fourteen lectures in the Horticultural Hall, Fairmount Park, by Dr. Rothrock. It was attended by more than previous members, varying from one to two hundred persons. Teachers in the public schools numerously availed themselves of this valuable opportunity of studying Botany.

"Dr. Rothrock feels it important to spend the later summer and autumn in Germany, in the pursuit of his studies. His course this year will be seven lectures, for which an appropriation is respectfully asked."

On motion an appropriation of one hundred and seventy dollars was made, from the income of the Michaux fund, for defraying the expenses of the seven lectures of Prof. Rothrock, and advertising the same. On motion of Mr. Price it was

Resolved, That one hundred dollars ($100) be appropriated out of the income of the Michaux fund, for a copy of the Michaux portrait, and frame, to be presented to the Park Commissioners, to be put in the Horticultural Hall, standing in the Michaux grove, where our Michaux lectures are delivered by Dr. Rothrock; and the Michaux Committee attend to the subject.

An appropriation of forty dollars ($40) was, on motion, made to defray the expense of an illustration for Mr. Ashburner's paper on Oil Sands in the printed Proceedings.

Mr. Fraley then stated that as the Society had left it with

him to appoint delegates to Boston, he requested the Secretaries to send information to each of the Board of Officers and to Dr. R. E. Rogers and to Mr. Wm. A. Ingham that he nominated them as delegates to represent this Society and assist on the 26th of May at the Centennial Celebration of the American Academy of Arts and Sciences in Boston.

The meeting was then adjourned.

Astronomical Approximations. IV. Nodal Estimation of the Velocity of Light. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, March* 19, 1880.)

The accuracy of my approximation to the apparent semi-diameter of the Sun* is confirmed by the following kinetic considerations, some of which, though seemingly of great fundamental importance and character, have been generally overlooked.

1. Matter has been usually regarded as composed of discrete particles. This hypothesis enters even into the kinetic theory of gases. If it is true, all force must be transmitted from particle to particle and time must, therefore, be required to overcome the inertia of masses.

2. Attraction and repulsion have been generally considered under the influence of central forces, varying inversely as the squares of the distances from the centres and, therefore, producing motions with variable velocity.

3. Waves, orbital undulations, and other cyclical motions, are generally propagated with uniform or nearly uniform velocity, although they are often accompanied by subordinate movements with varying velocity. Variable velocities are often converted into uniform or nearly uniform velocities, as in the case of conical pendulums, planetary rotations and orbital revolutions.

4. In all undulations, and in all cyclical motions through an undulating medium, there are tendencies to synchronism. The synchronism may be complete, producing equal cyclical motions in equal cyclical times; or nodal, producing harmonic series of cyclical motions which are completed in equal times.

5. Newton showed that if a centripetal force varies as the distance of a body from the centre, all bodies, revolving in any planes whatsoever, will describe ellipses and complete their revolutions in equal times;† that bodies which move in right lines, running backwards and forwards alternately, will complete their several periods of going and returning in the

* Proceed. Am. Phil. Soc. xviii, 380.

† Principia, B. I, Prop. 47

same times; * and that if a fluid be composed of particles mutually repelling each other, and if the density varies as the compression, the centrifugal forces of the particles will be reciprocally proportional to the distances of their centres, † as if indicating a reaction against a force which varies as the distance from the centre. The centripetal force is partially illustrated by the rotation of planetary bodies; the centrifugal, by the varying pressure of elastic atmospheres.

6. Such centripetal force as is above supposed, requires, for its complete manifestation, an omnipresence of activity, which is devoid of inertia, of ponderability, and of all other ordinary tests of material nature; an activity which may, perhaps, properly be regarded as spiritual.

7. Laplace found himself obliged to recognize an activity in gravitation, which is propagated with at least 100,000,000 times the velocity of light. ‡ This activity, he says, may be properly regarded as instantaneous. If it is spiritual, it may without difficulty be regarded as absolutely instantaneous throughout the universe. If it is material, it is difficult to conceive of any relation of elasticity to density which would be so great as 10,000,000,000,000,000 times that of the supposed luminiferous æther. Yet such are the requirements of the Newtonian law, that "the velocities of pulses propagated in an elastic fluid are in a ratio compounded of the subduplicate ratio of the elastic force directly, and the subduplicate ratio of the density inversely." § The importance of this law has been shown by the investigations of Graham, by the inquiries of English and German physicists into the relations between electromagnetic and luminous velocities, and by my own correlations of the force of solar rotation with the forces of light, gravitation and chemical attraction.

8. In any elastic or quasi-elastic medium, "if the distances be taken in harmonic [or arithmetical] progression, the densities of the medium at those distances will be in a geometrical progression." ‖ I use the term "quasi-elastic," in order to meet the views of Faraday, Preston ¶ and others, who prefer to treat all kinetic questions in accordance with lines of force.

9. The distances of projection, under uniform resistance, are proportioned to the living forces of projection, and inversely as the density of the resisting medium.

* Principia, B. I, Prop. 47.
† Ib. B. II, Prop. 23.
‡ Mec. Cel., X, vii, 22.
§ Principia. B. II, P. 48.
‖ Ib., B. II, P. 22.
¶ P. Mag., June, Sept., 1877. Preston does not give Maxwell's demonstration of the ratio $\sqrt{\frac{5}{9}}$, and neither he nor Maxwell seems to have been aware that I had used the same ratio of *vis viva* five years previously, in discussing results of gaseous energy (Proc. Am. Phil. Soc. Feb. 16, 1872, vol. xii, p. 394, foot-note). I showed that in the explosion of gases, the secondary centre of oscillation, on the return towards the centre, is at $\left(\frac{12}{18} - \frac{2}{3} \text{ of } \frac{12-9}{18} = \frac{5}{9}\right)$ of the extreme excursion.

10. In most, if not in all, physical investigations which introduce considerations of central force, velocity may be treated as a function of radius, time and mass.

$$v = F(r, t, m).$$

In undertaking to investigate successive conversions of spiritual, undulatory, and centripetal or centrifugal energy, astronomical phenomena furnish the most abundant, extensive, and varied opportunities for observation and illustration. Unfortunately, there is so much uncertainty in regard to the dimensions and densities of the principal heavenly bodies, that we can point to few results which are so precise as would be desirable. There are, however, some important indications of the operation of the foregoing laws, which are confirmed by terrestrial phenomena that are capable of very accurate measurement.

In Searle's Outlines of Astronomy, page 403, the following figures are quoted from the *Annalen der Sternwarte in Leiden*, on the authority of Kaiser. "The apparent diameter of Mercury, at a distance equal to the semi-axis major of Earth's orbit, ranges, according to different observers, from 5″.2 to 6″.9; that of Venus from 16″.6 to 17″.9; the apparent equatorial diameter of Mars from 9″.6 to 9″.2; its apparent polar diameter from 9″.4 to 9″.2. Similar disagreements appear in different estimates of the apparent diameters of Jupiter, Saturn, Uranus, and Neptune, at a distance for each planet equal to the semi-axis major of its orbit. Thus the equatorial diameter of Jupiter ranges from 39″.5 to 37″.1; its polar diameter from 37″.9 to 35″.1; the equatorial diameter of Saturn from 18″.5 to 16″.9; its polar diameter from 16″.8 to 15″.1; the diameter of Uranus from 2″.9 to 3″.6; that of Neptune from 2″.5 to 4″.4."

Kaiser adopts, as most probable values for the ratios of the several diameters to Earth's diameter, figures which I have increased by one per cent., in order to adapt them to more recent estimates of Sun's distance. These increased figures are given under r(I), in the following table. Under r(II) and in the subsequent columns, I give theoretical values which illustrate simple harmonic deductions from the above general function of velocity.

	Mass-denominator.	r(I).	r(II).	ρ.		g.	δ.
1. Mercury,	4865751	.34	.36	.387	$\rho^{\frac{3}{5}}$	= .53	1.484
2. Venus,	427240	.97	.98	.723	$\rho^{\frac{3}{5}}$	= .81	.822
3. Earth,	330985	1.00	1.00	1.000		1.00	1.000
4. Mars,	3093500	.53	.53	1.524	$\frac{1}{4}\rho$	= .38	.719
5. Jupiter,	1047.88	11.04	11.02	5.203	$\frac{1}{2}\rho$	= 2.60	.236
6. Saturn,	3501.6	9.10	9.20	9.539	$\rho \div \rho_1$	= 1.12	.121
7. Uranus,	22600	3.60	3.60	19.184	$\rho \div t$	= 1.13	.314
8. Neptune,	19380	5.80	5.84	30.034		.50	.086
9. Sun,	1	109.11	109.05			27.83	.255

The value which I have assumed for Earth's mass is the one which I have deduced from velocities of rotation and revolution and Struve's constant of aberration. The other mass-denominators are the ones which are

now generally adopted by astronomers. The semi-axes major are represented by ρ; the superficial equatorial acceleration of gravity, by g; the density, by δ; Earth's values being assumed as the units. In the expressions for g of Saturn and Uranus, $\rho_1 = 8.539$; $t = 16.9823$; ρ_1 being the mean distance between the centre of the belt of greatest condensation (Earth) and the primitive centre of rotary inertia (Saturn); t being the ratio between the time of Earth's rotation (a sidereal day) and the limiting time of satellite-revolution $\left(2\pi\sqrt{\frac{r}{g}}, \text{ at Earth's equatorial surface}\right)$. It is impossible, at present, to assign any more probable values for the planetary radii than those which I have given under 7(II). From those values and the masses, g and δ are readily found by the proportionalities, $\delta \propto m \div r^3$; $g \propto m \div r^2$. The relations of g to simple functions of the semi-axis major would be very striking, even if they were only approximately true. Although we cannot ascertain whether the relations are exact or not, the following considerations seem to increase the probability that they are correct indications of normal harmonic modifications of gravitating force by distance and time.

In comparing the gravitating force at the principal centres of early nebular activity, we may, then, acknowledge a strong probability:

1. That the force at the centre of reciprocity (Neptune), is one half as great as at the centre of the belt of greatest density (Earth).

2. That the force at the centre of rotary inertia (Saturn), is to the force at the centre of density, as the rotary centripetal force at Sun, is to the rotary centripetal force at Earth, the rotating tendencies being referred to Saturn as a centre.

3. That the force at the centre of nebulosity (Jupiter), is to the force at the centre of density, as the combined influence of the gravitating force at the centre of reciprocity and the rotary centripetal force at Jupiter, is to the combined influence of the corresponding forces at Earth.

4. That the force at the centre of nucleation (Sun), is equal to the velocity of light, divided by the time of a half-rotation; the half-rotation indicating the alternate oscillation of equatorial particles, from and towards the centre of gravity of Sun and Jupiter.

In extending the comparison to the subordinate centres within the belt of greatest condensation, we find a like probability;

5. That the force at Mars is to the force at the centre of density, as the combined force of gravitating *vis viva* at the centre of reciprocity and rotary centripetal force at Mars, is to the corresponding combined influences at Earth.

6. That the force at each of the inferior planets (Venus and Mercury), is represented by the ratio of projectile living forces to times of revolution.

Leaving the outer and somewhat doubtful territory, and entering upon surer ground, let us consider some of the obvious results of conversion of primitive force, with reference to centres of condensation.

1. If the velocity is constant, the radius of rotation or revolution must be proportioned to the time.

2. If radii, which were originally established by a constant velocity, are converted into radii of free revolution under equivalent central forces, the times of revolution must be proportioned to the $\frac{3}{2}$ power of the radii.

3. If radii of synchronous revolution and axial rotation are due to the action of a primitive constant wave-velocity, while nucleal radii are due to the collision of particles moving with parabolic velocity, the former velocity would be communicated in the time of a half-rotation, while the latter would be communicated in $\frac{\sqrt{2}}{\pi}$ of the same time.

4. Let us suppose that the ratio of the solar year to the terrestrial day originated in the constant velocity (1) of light, which is still represented by the equation of solar half rotation $\left(\frac{gt}{2} = v_\lambda\right)$; that the time-radii (r_t) were converted into radii of free revolution under equivalent central forces (2); and that corresponding nucleal radii (ρ_t) were established by parabolic collision (3). We should then have

$$\left(\frac{r_t}{\rho_t}\right)^{\frac{3}{2}} = \frac{\pi}{\sqrt{2}}$$

or, substituting the ratios which are represented by r_t and ρ_t,

$$\left(\frac{1 \text{ year}}{1 \text{ day}}\right)^{\frac{3}{2}} : \left(\frac{\text{Earth's semi-axis major}}{\text{Sun's semi-diameter}}\right)^{\frac{3}{2}} :: \pi : \sqrt{2},$$

The sidereal year is composed of the original nebular sidereal rotation and the 365.25636 additional sidereal rotations which are due to terrestrial condensation. Making these substitutions,

$$\left.\begin{array}{l}(365.25636)^{\frac{3}{2}} : x^{\frac{3}{2}} :: \pi : \sqrt{2} \\ x = 214.5365\end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\text{A.}$$

Among the obvious nodal influences of distance and velocity which may be reasonably supposed to have modified the kinetic undulations between the centres of density and of nucleation, the following may be specified :

1. The velocity of light, V_λ, or the projectile velocity which is equal to the sum of Sun's gravitating equatorial reactions during a half rotation, $\frac{gt}{2}$.

2. Sun's limiting velocity of revolution, $V_0 = \sqrt{gr}$, r being the equatorial radius.

3. Earth's limiting velocity of revolution, $v_0 = \sqrt{gr}$, at the equatorial surface.

4. Earth's superficial equatorial velocity of rotation, v_r.

5. Earth's semi-axis major, ρ_0.

6. Earth's diameter, $2r$, or the major-axis of limiting synchronous linear, elliptical and circular oscillation.

7. Moon's semi-axis major, ρ_1.

8. The ratio of variation between Laplace's limit, r_1, and the nucleal radius, r_0; $r_1 \propto r_0^{\frac{4}{3}}$.

From Struve's constant of aberration, equation A, and other well-known measurements, we find: $V_\lambda = 214.5365 r_0 \div 497.827 = .4309458 r_0$; $V_0 = 214.5365^{\frac{3}{2}} \times 2\pi r_0 \div 31558150 = .00062564 r_0$; $v_0 = \left(\frac{3962.82 \times 32.088}{5280}\right)^{\frac{1}{2}} = 4.9075$; $v_r = 2\pi \times 3962.82 \div 86164 = .288974$; $V_\lambda \div V_0 = 688.815$; $v_0 \div v_r = 16.98237$. The combined nodal action of V_λ, V_0, v_0, v_r, ρ_0 and $2r$ are represented by the equation:

$$\left.\begin{array}{l} \frac{V_\lambda}{V_0} \div \frac{v_r}{v_0} = \frac{\rho_0}{2r} \\ 688.815 \times 16.98237 = \rho_0 \div 7925.64. \\ \rho_0 = 92{,}711{,}850 \text{ miles.} \\ V_\lambda = \rho_0 \div 497.827 = 186{,}233 \text{ miles} = 299{,}705 \text{ kilometers.} \\ r_0 = \rho_0 \div 214.5365 = 432{,}495 \text{ miles.} \\ \rho_0 \div r = 23{,}395.4. \\ \frac{\text{Sun's mass}}{\text{Earth's mass}} = 330{,}997. \end{array}\right\} \quad \ldots\ldots\ldots \text{B.}$$

If we adopt Newcomb's estimates of Sun's diameter, mass and distance (*Popular Astronomy*, p. 528), the nodal value of V_λ would be 185,334 miles; the value as determined by Struve's constant of aberration, 185,475 miles; the discrepancy being only $\frac{3}{40}$ of one per cent. Michelson's estimate (299,820 km.) is about $\frac{1}{26}$ of one per cent. greater than mine, and about $\frac{1}{9}$ of one per cent. greater than Newcomb's.

Newton's law of the ratio of elastic densities to distances (8), the law of projection under uniform resistance (9), and the ratio of variation between Laplace's limit and the nucleal radius, all are illustrated by the lunar equations:

$$\left.\begin{array}{l} \frac{v_0}{v_r} \times \frac{32}{9} r = \rho_1 = 60.3815 r. \\ \left(\frac{v_0}{v_r}\right)^{\frac{32}{9}} r = \rho_0 \textit{ very nearly} = 23{,}622 r. \end{array}\right\} \quad \ldots\ldots\ldots\ldots \text{C.}$$

J. J. von Littrow's estimate for Moon's semi-axis major, cited by Searle (p. 406), is 60.2778, or about $\frac{17}{1000}$ of one per cent. less than the above result. The velocity of light, as deduced from the lunar value of ρ_0, is 188,040 miles, or nearly one per cent. greater than the value found in equations B.

I think no one will be likely to attach much weight to the larger value, but it is interesting on account of its indication of elliptical nebular influence, with a nucleal radius about one per cent. larger than Sun's present radius, and a major axis about one per cent. larger than Earth's present mean vector-radius. The nebular influence may be inferred from the fact that $\frac{32}{9} = 2 \times \left(\frac{4}{3}\right)^2$.

An Account of Two Maps of America Published Respectively in the Years 1550 and 1555. By Henry Phillips, Jr., A.M.

(*Read before the American Philosophical Society, March* 19, 1880.)

I.

In the *Cosmographia Universalis* of Sebastian Munster, published at Basle, in 1550, there occurs a large two page map of the New World which is so quaint, so singularly inaccurate, yet with all its faults so suggestive that a description cannot fail to be of interest to all who care to retrace the early history of our country.

The copy of Munster which is in the library of our Society is the German edition of 1563, but contains the same illustrations and maps that occur in the earliest copies of the work. As reprints took place, no changes seem to have been made in the letter-press, and certainly no alterations were effected in the charts and engravings.

North and South America are represented as a large island joined together, where Central America now exists, by a strip of land. All the upper boundary of North America is water. The coast line from what is now called Labrador and New Brunswick to the Gulf of Mexico is not badly outlined; Canada receives the name of *Francisca;* Yucatan is figured as a large island directly west of Cuba, which latter lies immediately to the south of the peninsula now known as Florida. The *Tortugas* islands are thrown far into the bosom of the Gulf of Mexico, to which body of water no name is assigned. Mexico itself appears as *Chamaho*, and a small island, *Panuco*, is represented near this country, off the mouth of a large river. Jamaica, spelled *Jamica*, lies to the south of Cuba; Hispaniola, directly to the east.

At the point where South America is joined to the Northern Continent is a country which bears the name of *Parias*, marked, "*abundat auro et margaritis.*" The configuration of Mexico is but poorly preserved, and the Pacific coast is dotted with random indentations of rivers and bays. Lower California does not appear, nor yet the Gulf which separates it from Mexico.*

A very large body of water, a continuation of that which forms the boundary of the Northern Continent, in shape and position not unlike to Hudson's Bay, stretches far down to within a short distance from the sea-coast, no great way off from the present site of New York city, New York. Probably this was placed upon the map in conformity with Indian reports of vast interior bodies of water, confusing the Great Lakes of the Northwest, with Hudson's Bay.

The peninsula now known as Florida is quite correctly drawn, although it does not bear any name, but a region of country corresponding

* According to Humboldt, Lower California had been recognized as a peninsula as early as 1539–41.

with the south-western parts of North Carolina, the north-western and northern portions of Georgia, the upper portions of Alabama and Mississippi, and the lower parts of Tennessee, receives the appellation of *Terra florida*. Above this region and trending to the north is a range of mountains, from whose western extremity a very large but nameless river takes its rise, in two diverging branches, at a considerable distance from the sea-coast, and ultimately empties its waters into the Gulf of Mexico. This seems to represent the Mississippi, and is in a reasonably accurate position, except that the junction of the two streams which compose it, is placed too near the river's mouth.* It is possible that some tradition of the Missouri may appear in the north-western branch of this stream.

To the west some distance off, is a large but nameless river taking its rise in a range of mountains which run from east to west. This may be the Rio Grande del Norte, the Texan boundary line.

The Isthmus of Central America is delineated as somewhat larger than it really is. South America is very incorrectly drawn, being too "squat" in appearance. A large river empties on its northern shores into the ocean, and on the land, at the easternmost projection of the Continent there stands a hut constructed of boughs, leaves and branches, from one of which latter a human leg is pendant. Lest there should be any doubt in the mind of the reader as to what all this meant, the word *Canibali* is printed upon this region to show the nature of its inhabitants. The bay of Rio Janeiro, although nameless, is shown, but appears to penetrate much farther into the main land than it really does. At the mouth of this reach of water are islands bearing the name 7 *insulæ Margueritarum*.

Farther to the south is a country marked *Regio Gigantum*, and still lower is the *Fretum Magellani*, separating the Southern Continent from a piece of land, whose termination is not shown on the map.

The configuration of the western coast is still more defective. Only one name appears on it, *Catigara*, which is far up towards the north-west. Printed upon the South American Continent are the words, "NOVUS ORBIS, *nova insula Atlantica quam vocant Brasilii et Americam.*"

The Western portion of the map is filled by the MARE PACIFICUM, in the lower part of which is drawn an old-fashioned, high-pooped, one-masted vessel, above which is the island *Zipangri* surrounded by ARCHIPELAGUS 7448 INSULARUM.

In the extreme north-west of the map is *India superior*, which contains *Cathay*, and its capital city, *Quinsay*. Below the ship are the *insulæ infortunatæ*.

II.

I turn from this map to one which, although published five years later, was evidently engraved at some very much earlier date.

The Novus Orbis of Simon Grynœus, published at Basle, in 1555, con-

*The Mississippi was discovered by De Soto in 1541, but the account of his travels was not published till 1557.

tains what was intended for a representation of the world as then known. It is a very large map, surrounded by a border of wood-cuts, very similar in subject and treatment to those found in Munster, exhibiting cannibals, wigwams, serpents, elephants, &c. Within the border are the names of various winds, and upon the seas are delineated remarkable monsters, fish and mermaids.

The portion of the map upon which America appears is the only one which will claim our attention.

North of Cuba there is no land whatever. This island is represented in the form of a parallelogram extending from Latitude 10° to Latitude 49° North, and lying between Longitude 280° and 290° East from the meridian of Madeira. At its southern extremity flows a narrow strait which separates it from South America, called on the map, AMERICA, TERRA NOVA. The shape of the upper portion of the Southern Continent is not badly preserved, but as it descends it becomes thinner and thinner, ultimately closing in a point of land without any suggestion whatever of the Straits of Magellan. On the northern coast are the *Canibali*, at the west is *Parias*, about Latitude 20° South is *Brasilias*. An island marked *Terra cortesia* almost due west of the northern extremity of Cuba lies in Longitude 310° E and Latitude 50° N. To the south-east of the centre of Cuba, lying between Latitude 20° and 30° North and Longitude 300° and 310° East, is an island called *Isabella;* east and south of this are a cluster of islands designated as *Insulæ Antiglia*, through which the Tropic of Cancer passes, and just above *Spagnolla*, which is to the south of Cuba.

This comprises all the land shown in the Western Hemisphere except the island of *Zipango*, due west of the centre of Cuba, in Latitude 10° to 30° N., Longitude 260° to 270° East.

The ocean between Europe and Cuba is called *Oceanus Magnus*.

NOTE.—The inaccuracy of this map is really surprising, when we consider the facilities then already in existence for verification. A Spanish *mappa mundi* and hydrographic chart published in 1573 (Lelewel. I. p. CXXXVI), presents the North American coast not badly delineated from Newfoundland down, although exhibiting some uncertainty. The Peninsula of Florida appears under that name, and Lower California is separated from Mexico by a body of water, and Mexico and Central America are quite correctly drawn. Yucatan is shown as a peninsula, and in its proper position. The conformation of the Gulf of Mexico is reasonably accurate. South America is justly drawn, although the portion below the Straits of Magellan is only partially exhibited. The *Canibales* still are attributed to the northern part of Brazil.

The Amazon river appears under that name.

On the Action of Hydrochloric Acid and of Chlorine on Acetobenzoic Anhydride. By Wm. H. Greene, M.D.

(*Read before the American Philosophical Society, March* 19, 1880.)

In September last, M. Loir published, in the *Bulletin de la Société Chimique*, a paper upon the double function (alcohol and aldehyde) of various acids and anhydrides. I will not discuss the general conclusions of this article, which has found its way into many of the collections of scientific literature, but the paper contains grave errors upon certain of the reactions of acetobenzoic anhydride. According to M. Loir, this compound behaves differently with hydrochloric acid and with chlorine, accordingly as it has been prepared by the action of acetyl chloride upon sodium benzoate, or of benzoyl chloride upon sodium acetate. Made by the last of these processes, it is decomposed by hydrochloric acid at 130°, into acetyl chloride and benzoic acid: chlorine at 140° converts it into acetyl chloride and chlorobenzoic acid. Under the same circumstances, the anhydride prepared by the first process is unaffected, but at 160° hydrochloric acid converts it into benzoyl chloride and acetic acid; at 170° under the action of chlorine it yields benzoyl chloride and chloracetic acid.

Acetobenzoic anhydride begins to decompose at a temperature below 150°, into acetic anhydride and benzoic anhydride, and at temperatures near this point it should act as would a mixture of the latter two bodies. Under the influence of hydrochloric acid it should yield acetyl chloride, acetic acid, benzoyl chloride and benzoic acid. Chlorine should act in an analogous manner. I have repeated the experiments of M. Loir, with the following results:

If dry hydrochloric acid be passed into acetobenzoic anhydride, at ordinary temperatures, the reaction is the same, by whichever process the anhydride may have been prepared: benzoic acid is deposited, and the tube conveying the hydrochloric acid becomes obstructed. On raising the temperature, acetyl chloride begins to distill at 55–60°, and the product obtained up to 130° is a mixture of acetyl chloride and acetic acid. If the heat be raised much above 130°, and if the current of hydrochloric acid be rapid, a small quantity of benzoyl chloride is carried over, and will be found in the distillate. The residue in the apparatus consists of benzoyl chloride and benzoic acid. If the anhydride be heated to 130°, or any other temperature, before passing the hydrochloric acid, the reaction is the same with the anhydride prepared by each process. However, it seems that the lower the temperature the greater the proportions of acetyl chloride and benzoic acid which are formed, while at higher temperatures (130-150°), the reaction yields acetyl chloride, acetic acid, benzoyl chloride and benzoic acid in about equivalent proportions.

Chlorine acts in an analogous manner: the products are the same in whichever manner the anhydride may have been prepared; but, with the exception of the acetyl chloride, these products are more difficult to

separate than those formed in the reaction with hydrochloric acid. Indeed, chloracetic acid boils at about 186°, and benzoyl chloride at 198° : in the experiments of M. Loir, the latter compound seems to have distilled over first, leaving the chloracetic acid in the retort. At temperatures near 150°, the products of this reaction are acetyl chloride, chloracetic acid, benzoyl chloride and chlorobenzoic acid ; at lower temperatures, the principal products are acetyl chloride and chlorobenzoic acid.

From his experiments, M. Loir considers that there is a difference in constitution between benzoyl acetate and acetyl benzoate, but the results of these experiments being erroneous, such a conclusion is unsustained. These bodies thus named are identical ; all of their reactions *under the same conditions* are the same, and they must be represented by the same rational formula.

Stated Meeting April 2, 1880.

Present, 12 members.

Mr. Fraley, Prof. P. E. Chase, Dr. R. E. Rogers, Mr. J. S. Price, Dr. Cresson, and Mr. Phillips signified by letter their acceptance of the appointment to represent the Society at Boston on the 26th of May.

Dr. Genth declined the appointment to prepare a notice of the late Prof. Roepper, on the score of ill-health.

A letter of envoy was received from the U. S. Naval Observatory in Washington.

A letter requesting contributions to the burnt library at St. John, New Brunswick, was received from Mr. Jas. Domville, Honorary Secretary, House of Commons, Canada, dated Ottawa, March 11, 1880.

Donations for the library were received from the Academies at Rome, Berlin, Brussels, and Philadelphia ; the Geographical Society at Bordeaux ; the Victoria Institute, R. Astronomical Society, and London Nature; the Societies at Quebec and Milwaukee ; the Boston Natural History Society ; Cambridge Museum C. Z., and New England Genealogical Society ; the Observatories at Washington and Mexico ; the University and Peabody Institute at Baltimore ; Mr. J. S. Price, and Mr. Henry Phillips, Jr.

The death of Guillaume Philippe Schimper, at Paris,

March 29, aged 72, was announced by the Secretary; and on motion, Prof. Leo Lesquereaux of Columbus, O., was appointed to prepare an obituary notice of the deceased.

A short communication "On the origin of planets" was received from Prof. Daniel Kirkwood.

Pending nominations Nos. 893 to 908 and new nominations Nos. 909 to 913 were read.

On motion of Mr. J. S. Price, based upon a letter from Dr. Cattell of Easton, the use of the Hall of the Society was tendered to the American Philological Association for its next annual meeting in July.

And the meeting was adjourned.

On the Origin of Planets. By Daniel Kirkwood.

(*Read before the American Philosophical Society, April* 2, 1880.)

If Laplace's hypothesis of the formation of planets and satellites from nebulous *rings* cannot be sustained* we may conclude that each planet, at its origin, was separated from a very limited arc of the equatorial protuberance; or, in other words, that instead of the separation of a ring, the centrifugal force produced a rupture at the point of least resistance in the equatorial belt. From the chasm thus formed a nebulous mass was thrown out, which in process of time was transformed into the outermost planet.† The tendency to separation around the equator would thus be relieved, and the ellipticity of the spheroid temporarily diminished. Further condensation, however, would again increase the centrifugal force until another rupture or outrush similar to the first would necessarily result. The formation of planets from these nebulous masses may thus be explained without the necessity of supposing such matter to have been slowly collected from continuous rings.

The origin of satellites is also very obviously accounted for. In short, where the ring hypothesis is encumbered with difficulties well nigh insuperable, the theory here proposed seems less open to objection. Not improbably, however, the ancient orbits of the secondary systems and perhaps also of some of the primary planets may have differed to a considerable extent from their present dimensions, as is shown by Mr. G. H. Darwin in his "Tidal Theory of the Evolution of Satellites."‡

* Proc. Amer. Phil. Soc., vol. xviii., p. 324.

† It is now believed by astronomers that the phenomena of temporary stars, such as those of 1572, 1866 and 1877, are produced by enormous outbursts of incandescent matter.

‡ The Observatory for July, 1879.

Stated Meeting, April 16, 1880.

Present, 17 members.

President, Mr. FRALEY, in the chair.

A letter of acknowledgment was received from the K. K. Central Anstalt für Meteorologie und Erdmagnetismus, at Vienna, dated March 17, 1880 (100, 103).

A letter of envoy was received from the Surveyor-General of India, dated Calcutta, March 1, 1880.

Donations for the Library were received from the Swedish Bureau of Statistics, Stockholm; Herr C. A. Dohrn, Stettin; the editor of the "Zoologischer Anzeiger," Leipsig; the Royal Academy, Brussels; Société de Géographie, and Révue Politique et Litteraire, at Paris; Accademia dei Lincei, Rome; Editors of the "Revista Euskara," Pamplono; Society of Antiquaries, Editors of Nature, and Mr. Joseph Prestwich, London; Natural History Society, Montreal; Connecticut Academy of Arts and Sciences, and American Journal of Science, New Haven; Trustees of the Astor Library; Editor of the North American Entomologist, Buffalo; New Jersey Historical Society; New Jersey State Geologist; Franklin Institute, Medical News, American Journal of the Medical Sciences, and American Journal of Pharmacy, Philadelphia; the Managers of Haverford College, Penna.; Mr. Henry Phillips, Jr., of Philadelphia; Cincinnati Society of Natural History; St. Louis Academy of Sciences; and M. Hugo von Meltzl.

No. 105 of the Proceedings of the Society, just published, was exhibited.

Mr. Lesley communicated the following extracts from a letter received from Mr. Lesquereux respecting an interesting discovery of North Carolina Triassic (?) plants in Bucks county, Pennsylvania:

"Yesterday (April 13) I found in a box, which I received about two weeks ago, a letter from Mr. John S. Ash, of Buckingham, Bucks county, Pennsylvania, with six specimens bearing vegetable remains of a Cycad: *Pterophyllum robustum* Emmons (a large specimen); *Calamites arenaceus* Brgt. (four specimens), outside and inside cylinder in two small specimens; a fragment of bark (undeterminable) like a *Cyclostigma*.

"These specimens, especially the *Pterophyllum*, are positively of the age of the Red of North Carolina, which Emmons refers to the Trias, and which White puts as high as the Lias or Jurassic; certainly not New Red as marked in the letter; still less Carboniferous.

"Neither Dana nor Rogers have seen this Formation in Pennsylvania, at least not in Bucks County. The fossils interest me very much.

Prof. Chase communicated three notes entitled:—

1. Astronomical Approximations. V. Cometary Paraboloids. 2. VI. Cosmical Determination of Joule's Equivalent. 3. Relations of Chemical Affinity to Luminous and Cosmical Energies.

Mr. Hall discussed some geological casts of a series from the State Geological Survey.

Pending nominations Nos. 893 to 908 were read and acted upon.

Pending nominations Nos. 909 to 913 were read.

Mr. Chase moved that Haverford College be placed on the roll to receive the publications (Proceedings and Transactions) of the Society. It was so ordered.

On scrutiny of the ballot boxes by the President, the following persons were declared duly elected members of the Society:

893. Dr. Austin Flint, Sr., of New York City.
894. Dr. Austin Flint, Jr., of New York City.
895. Dr. Roberts Bartholow, of Philadelphia.
896. Mr. J. Vaughn Merrick, of Philadelphia.
897. Mr. Horace Howard Furness, of Philadelphia.
898. Mr. Ellis Yarnall, of Philadelphia.
899. Rev. George Dana Boardman, of Philadelphia.
900. Mr. William B. Rogers, Jr., of Philadelphia.
901. Prof. Ogden N. Rood, of New York City.
902. Mr. Henry Martyn Chance, of Philadelphia.
903. Dr. William Thompson, of Philadelphia.
905. Mr. Carlisle P. Patterson, of Washington.
906. Mr. Hampton L. Carson, of Philadelphia.
907. Mr. Joseph C. Fraley, of Philadelphia.
908. Rev. Joseph A. Murray, D.D., of Carlisle, Pa.

And the meeting was adjourned.

PROC. AMER. PHILOS. SOC. XIX. 107. C. PRINTED JUNE 2, 1880.

Astronomical Approximations. V., VI. By Pliny Earle Chase, LL.D., Professor of Philosophy in Haverford College.

(*Read before the American Philosophical Society, April* 16, 1880.)

V. Cometary Paraboloids.

Some recent communications to the French Academy, by MM. Gaussin* and Faye,† have led me to re-examine some of my earlier discussions of the influence of projectile forces and perifocal collisions, upon nebular rupture and cosmical nucleation.‡ I have embodied some of the results of this examination in a comparison of my application§ of the general equation

$$x_n = \xi \eta^n \zeta^{n^2} \quad \ldots\ldots (1)$$

with Gaussin's analogous equation ‖

$$a = a\ k^n \quad \ldots\ldots (2)$$

If we let $r_0 = 1 =$ Sun's radius; $\xi = 16.164$; $\eta = 1.6252$; $\zeta = 1.013$, equation (1) gives a series of paraboloidal abscissas which represent important cosmical relations.

Bodies falling towards the centre of a cosmical system, from a distance nd, acquire the d-velocity of revolution, $(\sqrt{gd})$, at the distance $\frac{nd}{n+1}$.

Therefore, $\frac{d_0}{2}$, $\frac{2d_1}{3}$, $\frac{3d_2}{4}$, . . . represent points at which nebular subsidence would tend to produce rupture, with consequent orbital revolution at d_0, d_1, d_2 . . .

In Table I, P represents Stockwell's values for the secular perihelion points of rupture, in units of r_0; A, the values for secular aphelion; T, the theoretical rupturing distances as determined by equation (1).

TABLE I.

			P.	T.	A.
$\frac{1}{2}$ Mercury	=	$\xi\eta^2\zeta^4$	31.91	44 94	51.14
$\frac{2}{3}$ Venus	=	$\xi\eta^3\zeta^9$	72.11	77.91	83.07
$\frac{3}{4}$ Earth	=	$\xi\eta^4\zeta^{16}$	133.34	138.58	152.71
$\frac{4}{5}$ Mars	=	$\xi\eta^5\zeta^{25}$	210.96	252.93	279.38
$\frac{5}{6}$ Ceres	=	$\xi\eta^6\zeta^{36}$	438.66	473.69	511.84
$\frac{6}{7}$ Jupiter	=	$\xi\eta^7\zeta^{49}$	873.59	910.30	986.75
$\frac{8}{9}$ Saturn	=	$\xi\eta^8\zeta^{64}$	1606.19	1795.05	1902.03
$\frac{7}{8}$ Uranus	=	$\xi\eta^9\zeta^{81}$	3319.21	3632.14	3881.96
$\frac{8}{9}$ Neptune	=	$\xi\eta^{10}\zeta^{100}$	7408.37	7541.32	7626.46

* Comptes Rendus t. xc, pp. 518, 593.
† Ib., p. 566.
‡ Proc. Am. Phil. Soc. Vols. ix–xii.
§ Ib. xii, 520.
‖ Loc cit, p. 520. Equation (2) is a special case of equation (1), with $\zeta = 1$.

The perihelion and aphelion values for ⅓ Ceres were found by taking Newcomb's value for the eccentricity (.077) and mean distance ($2.769\rho_3 = 594.06r_0$). The other values of P and A are computed from Stockwell's elements of planetary distance and secular variation, taking $214.54r_0$ for the value of Earth's semi-axis major (ρ_3).

Dividing the values of T, in Table I, by the respective rupturing coefficients ($\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, . . .), and reducing to units of Earth's semi-axis major, we obtain the values in column C, Table II, for comparison with Gaussin's values, which are given in column G.

TABLE II.

	P.	C.	G.	A.
Mercury	.297	.419	.363	.477
Venus	.672	.726	.623	.774
Earth	.932	.969	1.073	1 068
Mars	1.311	1.572	1.848	1.736
Asteroid	2.132	2.760	3.183	3.954
Jupiter	4.886	5.092	5.483	5.519
Saturn	8.734	9.761	9.445	10.343
Uranus	17.681	19.348	16.269	20.679
Neptune	29.598	30.120	28.025	30.470

The perihelion and aphelion values of the asteroidal belt are represented by the mean distances of (140) and (183). All the other values in columns P and A are computed from Stockwell's elements. Gaussin's approximations to the distances of Venus, Earth, Mars, Uranus, and Neptune, are all outside of the limits of secular excursion for those planets respectively. My own values are all within those limits, and their approximations to the mean values are closer than those of any other similar series that has ever fallen under my notice.

The data for the construction of the cosmothetic paraboloid were derived from considerations of linear oscillation (α), *vis viva* (β,δ), nucleal rotation and synchronous orbital revolution (γ), spherical oscillation (δ), inter-stellar actions and re-actions of projection and attraction (ε), luminous undulation (ζ) and universal nebular subsidence and rupture (η).

α. The focus of paraboloidal action is Sun's centre. The locus of the directrix is also the locus of the linear centre of oscillation of Sun's diameter, referred to Sun's surface ($\frac{2}{3}d - r = \frac{1}{3}r$).

β, γ. The fundamental abscissa (ξ) is $\frac{1}{6}$ L; $\frac{1}{6}$ representing the relative *vis viva* of the linear centre of oscillation ($\frac{2}{3}$), and L being Laplace's limit, or the locus of synchronous rotation and revolution.

δ. The initial ratio ($\eta_1 r_1^2 = 1.66768$) differs by less than $\frac{1}{1000}$ of one per cent. from $\frac{5}{3}$; $\frac{2}{3}$ being the ratio of rupturing *vis viva* to residual *vis viva* of rotation ($1 - .4 = .6$).

ε. The planetary field is geometrically intermediate between the fields of solar nucleation and of stellar projection. There are 9 abscissas be-

tween Sun's surface and $\frac{1}{2}$ Mercury; 9 at loci of theoretical planetary rupture; 9 between $\frac{1}{2}$ Neptune and the region of the fixed stars.

ζ. The 27th abscissa from Sun's surface, or the 19th from ξ, $(\xi\eta^{19}\zeta^{361})$, is L M $\div r_0$; M being the elastic modulus of light at Sun's surface. (L = 36.36 r_0; M = 474600 r_0.)

η. The 28th abscissa from Sun's surface, $(\xi\eta^{20}\zeta^{400})$, is 46352440. Four recent estimates of the distance of *a Centauri* range between 45340000 and 48479500. Searle* cites authorities ranging between 44252.00 and 49169000. Newcomb says,† "The mean of all the measures of the parallax of this pair of stars hitherto made, gives 0″.93 as their most probable parallax, corresponding to a distance of 221000 astronomical units." This is equivalent to 47463340 r_0.

It will be readily seen that the elements of the paraboloid, ($\frac{1}{2}$ r_0, L, M), are entirely independent of any observed or theoretical planetary distance. No values can be assumed for those elements, within the limits of possible uncertainty, which will weaken the evidence that the nebula-rupturing position of the several planets, the time of solar rotation, and the interstellar spaces, have been determined by the laws which govern luminous undulation.

VI. Cosmical Determination of Joule's Equivalent.

In estimating heat of dissociation, Pfaundler has shown‡ that the mean should be taken between the temperatures of incipient and of complete dissociation. On this principle, in estimating the temperature of water-crystallization we should have regard to all stages of the expansion in molecular rearrangement, and take the mean (35°.6 F. = 2°C) between the temperatures of greatest density (39°.2 F = 4°C) and of complete crystallization (32° F = 0°C). So long as water continues to condense, its tendencies are centripetal and polar; while it is expanding, they are centrifugal and equatorial. The thermodynamic relations between heat and work should be shown in the comparative motions and temperatures of polar and equatorial waters, as surely, and with as abundant facilities for accurate measurement, as in the experiments of the laboratory or in the processes of the workshop.

Johnston's Physical Atlas gives 82°.6 F (28°.1C) as the mean temperature of the oceanic warmth-equator. This indicates a polar-equatorial difference of 82°.6 — 35°.6 F = 47 J, or 28°.1 — 2°C = 26.1 calories. The difference in gravitating measure can be readily deduced from the differences of motion. The velocity of equatorial rotation is 1525.78 feet, which represents a fall of $\left(\frac{1525.78}{32.088}\right)^2 \times 16.044$ ft. = 47 J. Hence we find J = 771.816 foot-pounds; Calorie = 423.44 kilogrammetres.

* Outlines of Astronomy, p. 396.
† Popular Astronomy, p. 208, foot note.
‡ Pogg. Ann., 1867, 131, 603.

The modulus (h) of the velocity of rotation (v_r) is: $h = \frac{v_r^2}{g} = \left(\frac{t_1}{t_0}\right)^2 r$.

Substituting the values of v_r, g, t_1, t_0, we find $h = \frac{1525.78^2}{32.088} = \left(\frac{5074}{86164}\right)^2 r$ $= 13.741$ miles $= \frac{1}{288.4} r$.

This gives 3949.084 miles for the polar radius, which is $\frac{1}{2}$ mile less than Bessel's estimate, and about $\frac{3}{10}$ of a mile less than Clarke's estimate from the results of the British Ordinance Survey. It accords very closely, however, as we might reasonably have anticipated, with the ellipticity $\left(\frac{1}{288.5}\right)$ as deduced from pendulum experiments. *

Relations of Chemical Affinity to Luminous and Cosmical Energies. By Pliny Earle Chase, LL.D.

(*Read before the American Philosophical Society, April* 16, 1880.)

All the principles which I have applied successfully to the discovery of harmonic relations of cosmical mass and density, should be applicable also to the discovery of similar relations of molecular mass and density, and to a consequent extension of our knowledge of chemical physics. The application can be made most properly by chemical experts, but some indications of the methods to be pursued may be acceptable, even though they come from one who makes no claim to any special chemical experience.

In 1833, Sir John Herschel published his remarkable attribution to the energy of the Sun's rays, "of almost every motion which takes place on the surface of the Earth. By its heat are produced all winds, and those disturbances in the electric equilibrium of the atmosphere which give rise to the phenomena of lightning, and probably also to those of terrestrial magnetism and the aurora."†

In 1856, Kohlrausch found that the ratio between the electrostatic and the electromagnetic units was apparently, and perhaps exactly, equivalent to the velocity of light‡ (v_λ).

In 1863, I found that the reaction of gravity to the elasticity and *vis viva* of atmospheric rotation, furnished a simple method for approximately estimating the Sun's distance by means of barometric fluctuations,§ and began a series of studies of cosmical and molecular harmonies which are dependent and consequent upon general kinetic laws.

In the year following,‖ I announced "the discovery of certain new relations between the solar and lunar diurnal variations of magnetic force

* Enc. Brit., 9th edition, vii, 601.
† Outlines of Astronomy, § 390.
‡ Pogg. Ann.
§ Proc. Am. Phil. Soc., ix, 287.
‖ Ib. ix, 425.

and of barometric pressure," showing a numerical equivalence between tidal attractions and magnetic disturbances. In 1873, in his "Electricity and Magnetism" (vol. ii, p. 127), Maxwell suggested the tidal hypothesis, apparently without knowing that I had already adopted it and adduced evidence to sustain it.

In 1875, I showed that analogues of Ohm's law are operative in General Physics, Electricity, Chemistry, and Cosmogony, and that Maxwell's deductions, when combined with my theoretical assumptions, led to the ratio: Earth's mass : Sun's mass : : 1 : 327710.*

Prof. Robert B. Warder has lately called my attention to the fact that the co-efficients of elasticity seem to lend some confirmation to Mendelejeff's and Meyer's hypotheses of periodical chemical functions, and thus I have been induced to look for further chemical illustrations of the universal influence of luminous undulations.

In the general equation of absolute measure, $u = F(l, m, t)$,

u, l, m and t represent, respectively, units of velocity, length, mass and time.

In Mechanical measure, the dimensions of the unit of force (k), which, in unit of time, communicates unit of velocity to unit mass, are $l\, m\, t^{-2}$.

In Electrostatic measure, the unit of quantity (ε), which repels an equal quantity at unit distance with unit force, is $l^{\frac{3}{2}}\, m^{\frac{1}{2}}\, t^{-1}$.

In Magnetic measure, the unit of quantity (μ), or strength of unit pole, is also, $l^{\frac{3}{2}}\, m^{\frac{1}{2}}\, t^{-1}$.

Kohlrausch's equation, $u = l\, t^{-1} = v_{\lambda}$, has been subsequently investigated by Weber, Thomson, Maxwell, and Perry and Ayrton, each successive examination increasing the probability that the electric dimensional value of $l\, t^{-1}$ is precisely equivalent to the velocity of light.

If we adopt for our mechanical unit, the maximum energy of gravitation in the solar system, we get the following equation:

$$g = l\, m\, t^{-2} = m\, u\, t^{-1} \quad \text{.....A}$$

The units of Electrostatic and Magnetic measure, both give the equation:

$$l^{\frac{3}{2}}\, m^{\frac{1}{2}}\, t^{-1} = mu.\ m^{-\frac{1}{2}}\, l^{\frac{3}{2}} \quad \text{.....B}$$

From these dimensional equations the value of the unit of absolute momentum (mu), is readily deduced. If we multiply (A) by the identical equation $t = t$, and (B) by the equation of orbital velocity ($v = m^{\frac{1}{2}}\, l^{-\frac{1}{2}}$†), we get $gt = mu = mv_{\lambda}$ C

$$\varepsilon v = mu = mv_{\lambda} \quad \text{.....D}$$

$$\mu v = mu = mv_{\lambda} \quad \text{.....E}$$

Under the guidance of foregoing investigations I find the following interpretation for this equivalence.

The centre of gravity of the solar system has a locus of secular range

* Ib. xiv, 607–9.

† Substituting r for l, the equations $g = \frac{m}{r^2}$ and $v = \sqrt{gr}$, give $v = m^{\frac{1}{2}} r^{-\frac{1}{2}}$.

relatively to Sun's centre, nearly, and perhaps exactly, equivalent to Sun's diameter.*

The two controlling bodies of the system, Sun and Jupiter, are of nearly equal density, and their centre of gravity, which is also the centre of greatest relative stability, has a locus of relative secular range about equivalent to $\frac{1}{8}$ of Sun's diameter, its secular perihelion, or locus of primitive rupture, being at Sun's surface. The gravitating motions beyond the limits of the system, and the æthereal motions at all points, should be referred to the centre of greatest stability; but as we approach that centre the gravitating tendencies towards Sun's centre become more and more preponderating. The gravitating motions are greatest at Sun's surface, where solar gravity (g_0), is 27.83 times as great as terrestrial superficial equatorial gravity (g_3). In solar rotation, the particles are subject to continual æthereal and gravitating forces, referable to the centre of stability and to Sun's centre, respectively.

Projectile velocities at Earth's surface, may be represented either by gt or by $\sqrt{gh}$, t being $\frac{1}{2}$ the time of flight and h being twice the virtual rise or fall. Reasoning from analogy we may, therefore, presume that t, in equations A, B and C, represents $\frac{1}{2}$ solar rotation, l represents the height of a homogeneous æthereal atmosphere, at Sun's surface, which would have a wave-velocity equivalent to that of light, and m represents a *minimum mobile*, or constituent molecule. These conditions are all satisfied by the values, solar rotation = 25.486 dys; t = 12.743 dys. = 1100985 sec.; $v_\lambda = 688.815\sqrt{gr}$; l = modulus of light = $(688.815)^2 r$ = 2206.5 Earth's semi-axis major = 73.64 Neptune's semi-axis major.

An æthereal sphere, rotating with velocity $\sqrt{gr}$ at Sun's surface, would have v_λ at $688.815\,r$. If $mu = v_\lambda$ in both cases, the densities would be inversely as the distances. In a condensing or expanding nebula, the nucleal radius varies as the $\frac{3}{4}$ power of the atmospheric or Laplace limiting radius, and in an elastic atmosphere the density varies geometrically, with an exponent inverse to the arithmetical variation of the distances or to the square of arithmetical variation or *vis viva* of rotation. Sun's mean distance is 23395.4 terrestrial radii, and $23395.4\,r \div (\frac{3}{4})^2$ of $688.815 = 60.38\,r$, which is the value of Moon's semi-axis major, as found by the limiting time-ratio of terrestrial rotation to satellite revolution. †

The tendency of all movements in elastic media, either to complete or to harmonic synchronism, should introduce some simple relations of chemical *vis viva* to *vis viva* of terrestrial motion. The law of Dulong and Petit, with Clausius's modifying substitution of the square of the molecular velocity for the specific heat, may be expressed by the equation $\frac{wv^2}{t} = C$, in which w represents the atomic weight, v the molecular velocity, according to the kinetic theory of gases, and t the absolute temperature. Since

* From *a priori* considerations I am inclined to think that the accordance is exact.

† Proc. Am. Phil. Soc., xix, 9.

the terrestrial movements are either independent of the absolute temperature, or standing in unknown relations to it, the simplest evidence of equivalent *vis viva* should be sought at some specific temperature, and in the most typical and most widely diffused gases. We have already seen that the universal typical liquid, H_2O, furnishes data for a ready determination of Joule's equivalent, at the mean temperature of solidification (2°C = 35°.6 F); let us examine the constituent typical gases (H,O) at the same temperature.

According to Clausius,* the mean velocities of the molecules are:

	At 0°C.	At 2°C.
Oxygen,	461 m = 1514 ft.	464.4 m = 1525.1 ft.
Hydrogen,	1844 m = 6050 ft.	1857.5 m = 6094.3 ft.

Earth's equatorial velocity of rotation (1525.78 ft.) accords with the molecular velocity of oxygen; its velocity of revolution is 16 times the velocity of hydrogen. If w_n represents the atomic weight of any perfect gas n, the velocity at 2°C may be found by the equation:

$$v_n = \frac{4v_r}{\sqrt{w_n}} = \frac{1}{16}\sqrt{\frac{gr}{w_n}}$$

The mean molecular velocity of oxygen and hydrogen (3048.7), is to Earth's orbital velocity, as the square of the time of fall to the centre from any distance d, is to the square of the time of orbital revolution at d.

The following comparison with the results of Cornu's and Michelson's experimental determinations of the velocity of light, and with my own estimation of Sun's mass and distance from the explosive energy of H_2O,† will show the closeness of agreement between the chemical and other physical approximations.

	Sun's Distance.	Velocity of Light.
Chase, H_2O	92,639,500 miles,	186,090 miles = 299,470 km.
Michelson,	92,748,000 "	186,300 " = 299,820 "
Chase, H	92,756,000 "	186,320 " = 299,850 "
" HO	92,803,000 "	186,420 " = 300,000 "
" O	92,849,000 "	186,510 " = 300,150 "
Cornu,	92,803,000 "	186,420 " = 300,000 "

It may be interesting, in this connection, to give two additional illustrations of the tendency to harmonic wave lengths in elementary spectra, of which I have already presented many evidences.‡

If we take $n = \frac{1}{2}\frac{1}{5}$, we find that Vogel's wave-lengths,§ of the ultra-violet lines in the spectrum of hydrogen, are strictly harmonic, as will be

* Phil. Mag., 1857, xiv, 124.
† Proc. Am. Phil. Soc., 1872, xii, 394.
‡ Proc. Am. Phil. Soc., xvii, 102–12, 295–301; xviii, 224–6.
§ Photographic News, February 20, 1880.

seen by the following table. Column T contains theoretical harmonic wave-lengths; V contains Vogel's measurements:

		T	V
α	$3968.4 \div 1$	$= 3968.4$	3968
β	$3968.4 \div (1 + 6\,n)$	$= 3886.6$	3887
γ	$3968.4 \div (1 + 10\,n)$	$= 3833.9$	3834
δ	$3968.4 \div (1 + 13\,n)$	$= 3795.3$	3795
ε	$3968.4 \div (1 + 15\,n)$	$= 3770.$	3770

The divisors ($\beta = 1 + 6\,n$; $\gamma = 1 + 10\,n$: etc.) give the following proportions:

$\beta - \alpha : \varepsilon - \alpha$: : mean *v.v.* of rotation : Equatorial *v.v.* of rotation.

$\varepsilon - \gamma : \varepsilon - \beta$: : wave *v.v.* : molecular *v.v.*

$\varepsilon - \delta : \varepsilon - \gamma$: : $\beta - \alpha : \varepsilon - \alpha$.

If we take $n = \frac{1}{12}$, Paalzow's oxygen lines* (P) are also nearly harmonic (T_1).

	T_1	T_2	P
$602 \div 1$	$= 602.$	602.	602.
$602 \div (1 + n)$	$= 555.7$	558.2	558.2
$602 \div (1 + 2\,n)$	$= 516.$	519.2	519.
$602 \div (1 + 3\,n)$	$= 481.6$	481.1	481.
$602 \div (1 + 4\,n)$	$= 451.5$	452.3	453.

The numbers in column T_2 are also harmonic, if we take $n = \frac{1}{33.5}$.

Stated Meeting, May 7, 1880.

Present, 15 members.

President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Mr. Ellis Yarnall, dated 105 S. Front Street, Philadelphia, April 21, 1880; Dr. Austin Flint, Jr., New York City, 14 West 33d Street, April 21; Mr. Joseph C. Fraley, 1833 Pine Street, Philadelphia, April 22; Mr. Horace Howard Furness, 222 West Washington Square, Philadelphia, April 24; Rev. George Dana Boardman, 3815 Walnut Street, West Philadelphia, April 26; Mr. J. Vaughan Merrick, Philadelphia, April 27; Mr. Wm. B. Rogers, Jr., 1000 Walnut Street, Philadelphia, April 27, and Mr. C. P. Patterson,

* Monatsber. der K. Akad. zu Berlin, Sept., Oct., 1878.

U. S. Coast and Geodetic Survey Office, Washington, D. C., April 21.

Letters of acknowledgment were received from L. Rütemeyer, Basel, May 20, 1880 (100,103); Society of Antiquaries, London, April 23, 1880 (103, 104); R. Astronomical Society, London, April 15, 1880 (103, 104); Victoria Institute, London, April 10, 1880 (103, 104); Royal Society of Edinburgh, Sep. 1879 (102); New Hampshire Historical Society, Concord, May 3, 1880 (105); Essex Institute, Salem, May 3 (105); New York Historical Society (105); New Jersey Historical Society, Newark, May 3 (105); Numismatic and Antiquarian Society of Philadelphia, May 3 (105), and Mr. Henry Phillips, Jr., Philadelphia, April 29 (105).

Also, Postals acknowledging the receipt of Proceedings No. 105 were received from the Museum of Comparative Zoölogy, Cambridge; Mr. Alex. Agassiz, Cambridge; Yale College Library, New Haven; the Astor Library, and American Ethnological Society, New York; Prof. J. J. Stevenson, New York; Historical Society, Philadelphia; Dr. T. Green, Easton; Mr. Wm. B. Taylor, Washington; Dr. Robert Peter, Lexington, Ky.; University of Cincinnati, Ohio, and the State Historical Society of Wisconsin, Madison.

Letters of Envoy were received from Dr. Geo. Engelmann, dated St. Louis, April 24, 1880, and the Department of the Interior, Washington, April 29, 1880.

A letter requesting some numbers of the Proceedings was received from the "Verein für Erdkunde" of Dresden, and was referred to the Secretaries with power to act.

Donations for the Library were received from the Governor General of India; Editor of the Zoologische Anzeiger, Leipsig; Dr. Hugo Von Meltzel; R. Accademia dei Lincei, Rome; Editor of the Revue Politique, Paris; Société de Géographie Commerciale, Bordeaux; Real Academia de la Historia, Madrid; Royal Astronomical Society, and Editors of Nature, London; Royal Society of Edinburgh; Essex

Institute, Salem, Mass.; Boston Society of Natural History; Museum of Comparative Zoology, Cambridge; American Antiquarian Society, Worcester; American Journal, New Haven; American Chemical Society, N. Y.; Historical Society, Numismatic and Antiquarian Society, Franklin Institute, American Pharmaceutical Association, Editors of the Medical News, and Journal of Pharmacy, and Mr. Henry Phillips, Jr., Philadelphia; Dr. Albert S. Gatschet, Washington; Johns Hopkins University, and Editors of the Journal of Mathematics, Baltimore; Department of the Interior, Washington; University of Virginia; Editor of the American Antiquarian, Chicago; Dr. Geo. Engelmann, St. Louis, and the Ministerio de Fomento, Mexico.

Mr. Moncure Robinson read a biographical memoir of the late Michel Chevalier.

Mr. Henry Phillips, Jr., presented for the Proceedings a paper by Prof. E. D. Cope, entitled, "Second Contribution to the History of the Vertebrata of the Permian Formation of Texas."

Pending new nominations Nos. 904 and 909 to 916 were read.

The Committee on the Michaux Legacy reported that the portrait of F. A. Michaux had been copied, and that it was now in the room for the inspection of the members.

Mr. Fraley reported the receipt of the last quarterly interest on the Michaux Legacy, amounting to $132.42.

The President suggested the desirability of the Society's now placing on its walls a portrait of Dr. Wood, deceased, the late President of the Society.

On motion of Mr. J. S. Price it was resolved, that a copy should be made for the Society, under the charge of the Hall Committee and the Curators.

The President reported that he had selected a delegation from the Society to represent it at the approaching Centennial of the American Academy of Arts and Sciences in Boston, and that six of those so appointed had signified their acceptance and would act in that capacity.

And the meeting was adjourned.

Obituary notice of Michel Chevalier. By Moncure Robinson.

(*Read before the American Philosophical Society*, May 7, 1880.)

I come before the Society for the first time for many years, in discharge of a duty devolved on me by you, the discharge of which revives in me many recollections both pleasant and painful. The eminent political economist and statesman of whom you have requested me to prepare an obituary notice, was not only a member of our Society, but one of my oldest and most attached friends, one whom I have known intimately for nearly half a century, and for whom my affection and admiration steadily increased, from the period of our first acquaintance, to the day of his death. It is not remarkable that it should have been so, for Mr. Chevalier was a man of heart, as well as head, whose whole life was devoted to the service of his country and his fellow men, and one who, whilst undemonstrative and apparently cold on a first acquaintance, was unusually benevolent and kind in his nature, and capable of the warmest attachments for those whom he thought possessors of, and appreciative of, such qualities.

You will be curious to know something of the early youth of such a man, and it is a gratification to me, to be able to give it to you, in some detail.

Mr. Chevalier was born at Limoges, *chef-lieu* of the department of the Haute Vienne, the 13th of January, 1806. He was the eldest son of Jean Baptiste Chevalier and of Marie Gurand, both natives of Limoges. They had four other sons, Auguste, Emile, Martial and Gustave, of whom the first three made their names known, both in their native country, and other lands; the first as Secretary General of the Presidency, in the days of the second Republic of France, from November, 1849 to 1852; the second as a highly educated and accomplished military and civil engineer, known to many of the citizens of Philadelphia more than forty years ago, when he commenced the practice of his profession as an assistant engineer, on the Philadelphia and Reading Railroad, then under construction, and who has since continued this career both in Europe and America, and been occasionally occupied in missions of his government in England, and on the Isthmus of Panama; the third, Mr. Martial Chevalier of the French Consular Department, who was for several years (within the last ten) the Consul General of France, at Quebec, and afterwards at Havana. I had not the advantage of a personal acquaintance with the father of these gentlemen, who at the time that his distinguished son, Mr. Michel Chevalier was making the name an honored one throughout the world, was only a small *commerçant* at Limoges, and confined there constantly by his occupations; but I had the pleasure, during a visit to France in 1837, of seeing often the mother of Mr. Michel Chevalier, and his devoted sister Pauline (afterwards Madame Moroche), and I then learned the secret of his rapid rise in public estimation as a writer and statesman. But I am proceeding too rapidly, and must go back a little, and redeem my promise to tell you something of an earlier period.

The boy Michel Chevalier entered as a boarding pupil the College of

Limoges, at the age of eleven, and made the most brilliant progress in his studies. He bore off nearly all the prizes in his classes, from the day of his entrance in this institution. He was equally distinguished in both the literary and scientific classes, but most remarked on, for his attainments in mathematical science. His taste and aptitude for the last, enabled him to undergo earlier than usual, the examination for the Polytechnic School at Paris, which he entered in the month of November, 1823, at the age of 17, one of the first in the list of candidates for admission of that year. At the end of 1825, he left the Polytechnic School, equally remarkable for his attainments in it, as at the Lycée of Limoges, to enter as *Elève Ingénieur* in the School of Mines. In 1829, he obtained his degree of Engineer of Mines, and was sent as Resident Engineer to the important department of Valenciennes.

Had the ambition of Mr. Chevalier been only professional, he would, with this starting point, have probably been like his distinguished contemporary, Mr. Le Play (the Commissioner-in-Chief of the Great Paris Exposition of 1867), at an early age, one of the eminent members of the profession of Mining engineers in Europe; but his reading and researches both in the Polytechnic School and School of Mines, in Paris, had gone far beyond the curriculum of studies in those institutions, comprehensive as that was, and including as it did every thing pertaining to the subjects taught in them. The quick intellect and remarkable memory of Mr. Chevalier enabled him, during the six years of study at these grand institutions, the chairs of which were then filled by world-renowned names, to spare time for outside reading and research, as well as the preservation of the early classical lore and polite learning imbibed by him at the Lyceum of Limoges; and his tastes were for everything useful and ornamental to our race, but especially for the useful, and what would add to the comforts of and elevate the masses.

The revolution which dethroned Charles X. and made Louis Philippe King of the French, which, in the language of General Lafayette, "made France a Monarchy with republican institutions," took place in the following year (1830). Many now living among us must recollect the excitement throughout the civilized world, which followed this change. It was naturally excessive in France, and it is not remarkable that at such a time minds of the highest order with corresponding aspirations, were most profoundly agitated. Mr. Chevalier in his various reading had been attracted by the writings and doctrines of St. Simon, in which at the commencement there was much to attract, as well as to find fault with. There was nothing like communism in them, but the reverse. The leading maxim of St. Simon was, "*To every one according to capacity, and to every capacity according to its works,*" and it is not surprising with such a motto on its banner, that St. Simonism should have found among its votaries, young minds of the highest ability and culture, and especially those who, like Mr. Chevalier, believed that the advancement of France in wealth and prosperity, would be greatly and rapidly promoted by improved lines of communication, especially by a well-arranged system of railroads, and more freedom of trade than existed previous to the revolution of 1830.

So it was, that Mr. Chevalier and other distinguished pupils of the Polytechnic School, and the Schools of Bridges and Highways, and Mines, became in 1830 St. Simonians, and he one of the leaders of the sect and editor of the *Globe*, its organ, until its suppression by the government in 1832, when Mr. Michel Chevalier as its *Redacteur-en-Chef*, was condemned to imprisonment for a year, from which he was released at the expiration of six months, and immediately appointed by Mr. Thiers, then Minister of Public Works (who had not forgotten in the St. Simonian, the young and talented Engineer of Mines of the Department of the North), to visit the United States, to inquire minutely as to its canals and railroads, and the financial and banking systems, both of the States and the General Government.

In this mission, including a visit of a few months to Mexico, Mr. Chevalier occupied about two years in 1833, '34 and '35; and during his travels in the United States, he addressed to the *Journal Des Debats*, from different points on his route, frequent letters, beautifully written, exhibiting large reflection, both on the subjects of his mission, and others of equal interest, and indicating with great tact many industrial hindrances in his native country, which he considered burdensome. These letters, with some slight changes, were published in 1836, in two octavo volumes, and gained him immediately the spontaneous plaudits of eminent men of both continents, and a high reputation among the writers and thinkers of Europe. Mr. Gallatin said of them that they were the most graphic and truest view of the social condition of the United States; and the great Humboldt wrote to him that his book might be considered a treatise on the civilization of the people of the West. He was indebted to this work for an appointment by the French government on a mission to England, in 1837, to study there, the causes and effects of the commercial crisis, which commencing in the United States at the close of 1836 had extended to England in 1837. This mission proved an unfortunate one for him. A few days after his arrival in London, in returning from a session of Parliament with Mr. Bourqueney, the then Chargé d'Affaires of France to England, in the carriage of the latter, the horses ran away and upset the carriage. Mr. Bourqueney was but slightly injured by the accident, but Mr. Chevalier having fallen on his head, was taken at once to the house of the French Minister, was for several days insensible, and his life for some weeks in serious peril; and it was only after passing several months in the south of France, and at the Pyrenean Baths, that his health was sufficiently re-established to admit of his resuming his labors.

At the expiration of a year from his recovery, near the close of 1838, he published his celebrated work, entitled "*The Material Interests of France, its Roads, Canals, and Railroads.*" This work was, to a great extent, a programme of ameliorations, many of them suggested by him, soon to take place, and which made the France of 1850 scarcely recognizable by travelers who had known well the France of 1840.

Such had been the brilliant and useful career, and such was the position

of Mr. Chevalier in the winter of 1838–39, when he was scarcely thirty-three years of age. Honors and distinctions were then bestowed on him rapidly. Appointed "Master of Requests" in 1836, he became successively Counsellor of State, member of the Superior Council of Commerce, Chief Engineer of Mines, and in 1841, at the age of 35, successor of the celebrated Rossi, as Professor of Political Economy in the College of France. No appointment could have been more gratifying to Mr. Chevalier than this. His lectures were to be on subjects familiar to him, to which his thoughts had been given from the time of his entrance in the Polytechnic School, and it was a labor of love to him to prepare and deliver them. Though the recipient since of many distinctions and honors, among them that of Senator of France in 1860, and charged with corresponding duties, and obliged occasionally to devolve on a substitute his duties as professor, he continued to hold the Professorship of Political Economy, in the College of France until his death, with the exception of a brief period after the Revolution of 1848, when he was deprived of his chair by the Provisional government of the day, but which was restored to him in the course of a few months by a vote of the National Assembly.

Mr. Chevalier, though eminent as a Political Economist and Publicist, and zealous always in promoting what he believed to be the interests of his country, was in no sense a party man. He was an admirer of Mr. Thiers, and an attached friend of Count Molé, successive Ministers of Louis Philippe, but he had no difficulty in opposing important measures recommended by them as Ministers, of which he did not approve; and he manifested signally in 1870 his independence when he stood in the Senate Chamber almost, if not altogether alone, in voting against the Prussian War. When in France in 1867, on hearing his name mentioned as a man of pre-eminent ability by a gentleman of influence in the Orleanist Party, and bearing one of the renowned names of France, I was tempted to ask how it came to pass that Mr. Chevalier had not been in the Cabinet of either Louis Philippe or Louis Napoleon. His reply was simply "*Il traverse trop son chemin*," showing that in Empires and Monarchies, as in the United States, those who would be cabinet officers and dispensers of government patronage, must give up to a greater or less extent their independence of opinion, which conscientious and really able men cannot readily surrender.

Mr. Chevalier was elected in 1845 a Deputy of the Department of the Aveyron, and during the same year was married to Mlle. Emma Fournier, a highly educated and accomplished young lady, the only daughter of a large and wealthy manufacturer of Lodêve in the Department of the Herault; and in 1851 he was elected a member of the Institute of France, in the Department of Moral and Political Sciences.

He had thus attained at the age of 45, all that, if a selfish or merely ambitious man, he could have desired. With an ample income from the honorable positions held by him, and occasional contributions of his well-considered views, on subjects of public interest, to the regular periodicals and

daily press of Paris, and his excellent wife (as the future proved her to be) the almost certain inheritor of a large estate, there was every temptation to him, laboring as he did under the disadvantage of a very delicate constitution, to spare himself in the future; but his mind and heart were of that order which considers nothing done whilst anything remains to be done, for his country and humanity; and he regarded the advantages attained by him in the prime of life, only as stepping stones to increased usefulness.

In 1852, as Counsellor of State, Mr. Chevalier was placed in the section of Public Works.

In 1855, he acted as President of the French section of the World's Exposition of that year in Paris; and for the ten years between 1860, in which year, as above observed, he was made Senator, to 1870, when the Empire ceased to exist, he took an important part in all discussions, in and out of the Senate, pertaining to financial and industrial questions. The most signal and important service rendered by him to his country during this period, was the commercial treaty of 1860 between France and England. Of this treaty, his son-in-law, Mr. Paul Leroy Beaulieu, a member of the Institute, and the distinguished *Rédacteur-en-Chef* of the *Economiste Français*, in the number of that Journal of the 6th of December last, says:

"The conception of the treaty of 1830 was due entirely to Mr. Michel "Chevalier. It was he who of his own sole motion, without any official mis- "sion, went to England to see Cobden and Bright, to propose to them an "arrangement in this way. Cobden had at first some hesitations. A treaty "of commerce appeared to him a *compromise*, contrary to true economical "doctrines. Mr. Michel Chevalier converted him, and then addressed "himself to Mr. Gladstone. Assured of the coöperation of the English "Government, Mr. Chevalier then returned to France, explained his "views to the Emperor, and obtained his support of them. Several of the "Ministers of that date were nevertheless opposed to a step so decisive in "the way of commercial liberty, but Mr. Rouher comprehended the great "usefulness and productiveness of the projected treaty of Mr. Chevalier. "Thus this great work, the treaty of 1860, which marks a new evolution "in the economical relations of nations, was in its principles, as well as its "initiation, a private one due to the inspiration of Michel Chevalier and the "adhesion of Richard Cobden. Nearly twenty years have passed upon the "treaty of 1860, twenty years which will be counted as among the most "agitated of History. The War of Secession of the United States, the "War of 1866, the French and German War, have disturbed the conditions "of the experiment of commercial liberty. Nevertheless, in spite of all these "disturbing elements, all the losses of capital, and all the uncertainties "which have during this period been the consequence of these great in- "ternational conflicts, the reform of 1860 has proved to be a beneficent "one; it has been so to such an extent, that though this treaty has been "denounced for nearly ten years, nothing has yet been found to substitute "it. It has been prorogued from year to year without the power, without

"daring to modify it. What might have been its results, had the experi-
"ment been made in a period of peace, like that between 1815 and 1848?"

It was certainly due to this treaty which had been so effective during the previous ten years, in connection with her admirable system of railroads in developing her resources and increasing her wealth, that France was enabled to recover so rapidly from the results of the Prussian War, and to exhibit before the end of the next ten years, a picture of prosperity surpassed by that of no other country in Europe.

The above extract from the *Economiste Français* reminds me of a misapprehension in this country of the views of Mr. Chevalier on the subject of free trade, which I will avail myself of this opportunity to correct. The visit of Mr. Chevalier to the United States in 1833, had the effect of modifying very materially his views on many subjects. Previous to this visit, I think it not unlikely that the great, and in many cases, absurd, hindrances in France in the way of exchanges, both at home and with other countries, may have caused him to have entertained extreme free trade views; but Mr. Chevalier was a man of profound reflection, aiming at truth on that and every other subject to which his thoughts were directed, and eminently practical in his conclusions. After his return to France in 1835, the subject which first occupied his attention more than any other, was that of improved communications by *canals and railroads*, and it has been most fortunate for his country, that the programme of these given in his great work published in 1838, on *"The Material Interests of France,"* was so closely followed. He abhorred the idea of allowing free competition to the extent admitted in England as well as in America in canals and railroads, believing the plan of giving an act of incorporation for either, to any association asking it, as not only permitting an unnecessary waste of the capital of the country, to an immense extent, and destructive of confidence in such investments, but as impairing the power of really valuable works to provide such accommodations for the public at fair rates, as they could otherwise afford, and as it would be to their interest to give, as well as the policy of the government to require. He believed, in short, in the right of eminent domain being used only in the case of improvements of decided value, and when used, in the rights of the public, being in all cases carefully guarded, and the accommodations of the improvement afforded at the lowest charges consistent with a fair remuneration to its owners; objects which could not be united under a system of free competition. As a consequence of the adoption of these views by his countrymen, there is no country in the world where so small a proportion of the capital invested within the last forty years in canals and railroads, has been wasted, or where traveling is safer, or in which travel and trade are accommodated, at more reasonable rates than in France.

It was impossible for one entertaining such views in regard to improved communications to be a *reckless* free-trader; and Mr. Chevalier, I have reason to believe, was on the subject of international commerce as conservative in his views, as he was in regard to railroads and canals. He believed

in the adoption of protective duties to a moderate extent for nascent industries, as in a patent-right or a copy-right for a limited time, for the protection of an author or inventor, and in the propriety of such duties as might be necessary to keep up a few industries essential to the defence of a country in time of war; but beyond this, he considered the protection given by a tariff based on revenue principles, all that was justifiable or judicious. Practical as he was in all things, I have little doubt that his preference for an arrangement *by a treaty* between England and France, instead of the action of the legislative bodies of the two countries, was founded on the idea that what was advisable in the way of protection for each country, might best be effected by treaty.

Mr. Chevalier's connection with governmental affairs ceased with the Empire in 1870, and he consecrated himself for some time afterwards, to his duties as Professor in the College of France, and as member of the Institute; but his taste for great and useful enterprises continued, and he devoted himself in 1875, with his accustomed zeal, to carrying out one of his engineering conceptions, that of a submarine railroad between Calais and Dover, as a means of binding together more closely France and England. He organized during this year a society for the purpose of making examinations in reference to the work, of which the Messrs. Rothschild Brothers, and the railroad companies of the North, were members. This Society, of which he was the initiator, and of which he continued until his death the President, obtained of the government a concession of the submarine railroad, and Mr. Chevalier entered on the examination of the bed of the Channel, and an ascertainment of the strata underneath, with that ardor and perseverance which were parts of his nature. He had communicated with me as an old friend and confrère, when he first conceived the idea of the work, as to its practicability, and sent me, from time to time, lithographed copies of the soundings, and statements as to the character of the chalk formations, found at various depths below the level of the sea, on the line of the tunnel on both sides of the Channel, which up to the time of his death, were highly favorable. But the events in the East, and the condition of things in England within the last three years, have prevented, so far, the work itself being entered on, and it may not for some time, or perhaps never, be executed; but if it should be, the name of Mr. Chevalier will be always connected with it, as its first projector and promoter.

This and other plans for the benefit of his country and the world, occupied, I might say, to the last moments of his life, the thoughts of Mr. Chevalier. I speak knowingly on the subject, having been a recipient during his last and fatal illness (after it had progressed to the point that he could write only in a recumbent posture), of eight letters in less than six weeks, in which the submarine tunnel, and other subjects of public concern, were referred to, and discussed by him. In one of them, he speaks of an experiment he is making on his estate in the South of France, of growing American grape vines for the purpose of engrafting French grape vines on American stocks, as a means of arresting the Phyloxera, at present so destructive to the great wine industry of France; and I find from

the obituary notice of Mr. Paul Leroy Beaulieu in the *Economiste Français*, from which I have made an extract on a previous page, that from his bed of suffering on the evening preceding the day of his death, he directed, as President, a letter to the submarine railroad association, so impossible it was for him to avoid thinking (or acting) on subjects which interested him!

The life and labors of Mr. Chevalier ended on the 28th of November last. He died the morning of that day, at his country residence, Mont Plaisir, near Lodêve, in his 74th year, which would have been reached on the 13th of January of the present year.

I venture to translate from a letter from his affectionate and lovely daughter, Madame Paul Leroy Beaulieu, written me on the 2d of December, four days later, the portion communicating the sad intelligence of his death. "When (says Madame Beaulieu) my father received your last letter, he was already confined to his bed, from which he was no more to rise. His ankle was being rapidly cured, but as the cure of the ankle progressed, there came on successively a rheum, derangement of the stomach, and aftes in the mouth, all ills which under other circumstance would easily have been borne, but which were too much for a frame for some years enfeebled.

"My poor father died on the 28th of November, after four weeks of suffering, and an agony of twenty-six hours. He preserved his consciousness until within a few hours of his death.

"All the physicians whom we have consulted, concur in opinion that his health had been *used up* by his labors; and, in spite of all the watchful care which surrounded him, especially that of my mother, who never left him night or day for more than two years, the Almighty has not allowed us to preserve him.

"I have thought, dear sir, that these details in regard to so old and sincere a friend, would be of interest to you, and for this reason I have written you.

"I wish also to say to you that all those whom my father has loved are dear to us, and that we will be happy to learn that the painful trials we are undergoing, have been spared to them."

Mr. Chevalier's life was in fact one of almost constant mental labor, from his childhood to his death. This was so much his normal condition, that even at his hospitable home, he appeared often *distrait* and silent when thinking over something said by a guest which struck him as worthy of consideration, but in regard to which he was not at the moment prepared to express his concurrence, or dissent. That he was not unobservant, was evident from his accurate and minute recollection of men and things. He had one of the most retentive memories I have ever known, and seldom, I think, forgot anything he had seen or read, worthy of thought or remembrance.

With such varied ability, and such a taste for, and power of, labor, few subjects worthy of it escaped his attention, or were left, if within his purview, untouched by his pen. In one respect he was exceptional, and

perhaps stood alone, among the writers of his epoch. This was his rare union of a mind eminently scientific, with a beautiful imagination. This combination of what are usually deemed opposite mental traits, is apparent frequently in his writings, but is perhaps most apparent in his letters on North America, and in a smaller work published in 1863, on "Ancient and Modern Mexico."

With so quick an intellect, so fine a memory, and love of and capacity for labor, a great deal was written by Mr. Chevalier during the last half century, besides the works mentioned in this memoir. Independently of his letters from America which first attracted attention to him as a writer, he published in 1840, a large work on the "Lines of Communication and Public Works of the United States," with an accompanying atlas (two volumes in quarto and the atlas in folio), which has never been translated in English, but which made the internal improvements of the United States, at that time, better and more accurately known to Europeans than they were to ourselves. His lectures at the College of France and other works on Political Economy, and his brochures on Gold and Currency, are well known to readers on those subjects. In addition, he gave to the world a magnificent introduction to the reports of the International Exposition of 1867, and was a co-laborer during the whole period in the principal periodical journals of France, as well as a contributor of able articles on subjects of the day to the *Journal Des Debats.*

On the 1st page of this memoir, I mentioned having had "the pleasure during a visit to France in 1837, of seeing the mother of Mr. Chevalier, and his devoted sister Pauline (afterwards Madame Moroche) and learned then the secret of his rapid rise in public estimation, both as a writer and statesman."

Mr. Chevalier and myself were in Paris, students of our respective professions, in the years 1825, 1826, and 1827, but did not meet there at that time. Our acquaintance commenced when he visited this country on his mission from Mr. Thiers in 1833. He then brought me a letter from one of our Paris cotemporaries, asking my assistance to him in his objects, which it gave me pleasure to render. The more I saw of him the more interesting I found him, and when he left America to return to France in 1835, we had become attached friends. When I afterwards visited Paris in 1837, he was one of the first persons to call on me, and I was made literally at home, whenever I could spare time to visit him, in his modest apartment, I forget the street, and number; but it was not far from mine, which was at the Hotel de Londres in the Place Vendome.

Instead of the *appartement de garçon* in which I had expected to find my friend, I found his remarkable mother, and his sister Pauline and young brother Martial, residing with him; the two first, to relieve him of the trouble of taking care of himself, and thereby leave him more time for his studies and labors, as well as to make his time more pleasant in the brief intervals he allowed himself for recreation; and the younger brother brought with them to have, under the guardianship of his mother and sister, the advantages of Paris training without its perils.

Cordially received as I always was by every member of this little household, I soon discovered in the gentle, affectionate and unpretending mother of the Chevaliers, a lady of remarkable mind and energy, whose ambition it was to make every sacrifice, and to do everything in her power to forward the honorable aspirations of her sons, and especially of Mr. Michel Chevalier the eldest.

I had a few months later, on the occasion of his dangerous accident at London, a proof of the devotion of his young sister Pauline. Mr. Chevalier and myself occupied at the time of its occurrence a common parlor with adjoining chambers at Long's Hotel. How the news of the accident reached Paris so soon, I have never known. Electric telegraphs had not been introduced to any extent, and the only roads which then existed between Paris and London were the French paved turnpikes and English McAdamized roads; but on the third or fourth night after its occurrence [a shorter time than a reply to my letter to the family announcing it could have been received by me], I was awakened at 4 A. M. by a loud knocking at the door of my chamber, which proved to be from Mlle Pauline and her brother Auguste, who on hearing of the accident, rushed to London as fast as the *Malle-poste* in France and post-horses in England could carry them, to nurse their brother Michel; and who, after hearing my account of it, went at once to the French Embassy, and remained there constantly with him, until he could be removed without hazard, to Paris.

One can scarcely imagine surroundings more favorable to high development in an elevated and affectionate nature, than were those of Mr. Chevalier in his modest Paris apartment, of which I have given a glimpse only, in the above paragraphs.

Before closing this obituary notice, I should say a few words of Mr. Chevalier in private life. I have never known more beautiful family relations than those which existed in his household. But the extract from the letter of Madame Leroy Beaulieu given in this, brief as it is, tells what these were, better than anything which I could say on the subject. Few persons, I think, knew or understood Mr. Chevalier better than myself, and I can truly say that his nature was a most kindly and affectionate one to everybody; but no one could surpass him in his willingness, however occupied, to aid and assist young men desiring his counsel and advice in the opening of their careers. On this subject, I recollect hearing his excellent mother-in-law, Madame Fournier, complain of his good-heartedness in being willing, notwithstanding his unremitting labors, to give his time and advice, as well as pecuniary aid, to any one asking his assistance or counsel; and through life he enjoyed the reputation of unusual benevolence. In the language of Mr. Paul Leroy Beaulieu, from whom I have several times quoted in this notice, he looked usually at the best side both in men and things. He believed in Providence, in the definitive triumph of the good and true. His mind thus anchored, manifested increased resources under exigencies, and he found himself preserved under the most difficult circumstances from all discouragement.

*Second Contribution to the History of the Vertebrata of the Permian Formation of Texas. By E. D. Cope.**

(*Read before the American Philosophical Society, May 7, 1880.*)

Since my synopsis of this subject, published in May, 1878, the accession of much new material had enabled me to make a number of important additions to it. Notes which record some of these may be found in the American Naturalist for September and December, 1878, and for April and May, 1880. The substance of these is included in the present essay.

At the meeting of the National Academy of Sciences, held in New York, in November, 1878, I pointed out that the scapular arch in the *Pelycosauria*† consists of scapula, coracoid and epicoracoid, which form a continuum in the adult, in the same way as the three elements of the pelvis in the same group form an os innominatum. The tibiale and centrale of the tarsus unite to form an astragalus which has no movement on the tibia. The fibulare forms a calcaneum. The distal side of the astragalus presents two faces, one of which receives a large part of the proximal extremity of the cuboid.

The structure of the scapular and pelvic arches is identical with that already described by Owen as belonging to the *Anomodontia*. Several important characters distinguish this group from the *Pelycosauria*, but the two together form an order which I have thought must, for the present at least, be retained as distinct from the *Rhynchocephalia*. The characters of this order, with its two sub-orders, are as follows:

THEROMORPHA Cope. Scapular arch consisting at least of scapula, coracoid and epicoracoid, which are closely united. Pelvic arch consisting of the usual three elements, which are united throughout, closing the obturator foramen and acetabulum. Limbs with the phalanges as in the ambulatory types. Quadrate bone proximally united by suture with the adjacent elements. No quadratojugal arch.

Pelycosauria. Two or three sacral vertebræ; centra notochordal; intercentra usually present. Dentition full.

Anomodontia. Four or five sacral vertebræ; centra not notochordal; no intercentra. Dentition very imperfect or wanting.

The *Rhynchocephalia* have no distal ischio-pubic symphysis, and apparently no epicoracoid bone. They have an obturator foramen, and a quadratojugal arch.

The order *Theromorpha* approximates the *Mammalia* more closely than any other division of *Reptilia*. This approximation is seen in the scapular arch and humerus, which nearly resemble those of the *Monotremata*, especially *Echidna;* and in the pelvic arch, which Owen has shown in the sub-order *Anomodontia* to resemble that of the Mammals, and as I have

* Abstract read before the National Academy of Sciences, April 20, 1880.

† See Proceed. Amer. Philos. Soc., 1878, p. 511 and 528.

pointed out, especially that of *Echidna*. The tarsus is also more mammalian than in any other division of reptiles. In the genus *Dimetrodon* the coracoid is smaller than the epicoracoid, as in Monotremes. The pubis has the foramen for the internal femoral artery.

A not less remarkable characteristic of the *Pelycosauria*, as represented by *Clepsydrops* and *Dimetrodon*, is their resemblance to the *Batrachia* in some important respects. This is seen in the scapular and pelvic arches, which resemble very much those of the *Urodela*, and of such types as *Eryops*. The small coössified coracoid only differs from that of *Eryops* in having two deep sinuses of its free border. The general form of the pelvis is similar, but the ilium has a special and peculiar articular face for the sacral diapophysis, which is wanting in *Eryops*. In the inferior arches, the absence of obturator foramen, and general boat-like form, are the same in both; but in the *Pelycosauria* the symphysis is not so deep, and the walls less massive. But the resemblance of these arches to those of the *Batrachia* in question is greater than to those of any order of reptiles.

Another point of resemblance to the *Batrachia* is seen in the humerus. In my previous essay on the *Pelycosauria* above cited, I defined six types of humerus as occurring in the Texas Permian. Two of these were described as wanting the foramen,* while the others were stated to possess it; other differences between these types exist, but they were not mentioned. Since then Gaudry has added a third form to the former group, which he has ascribed to a reptile under the name of *Euchirosaurus*. I have detected this form in my Texas collections together with another, which has no condyles at either extremity. Thus eight forms of humerus are found in this formation.

That the type with the supracondylar foramen belongs to the *Pelycosauria* has been satisfactorily shown by its presence in the skeleton of *Clepsydrops natalis* and in *Cynodraco major*, where Owen first identified it. I find the type without this foramen frequently associated with the skeletons of *Eryops*, and other *Stegocephali*. There is no other element that can be regarded as the humerus of this type. It moreover has distinct points of resemblance to the humerus of existing *Batrachia*, parallel with similarity traceable in the femora of the extinct and recent genera. There is then every reason for believing that we have in the humerus of *Eryops* and its allies, an element which approaches closely in its characters to that of the *Pelycosauria*, and hence to that of the *Monotremata*.

There are some other peculiarities which constitute resemblances of the same kind. The tooth bearing elements of the roof of the mouth have batrachian character. Such is the densely packed body of teeth seen in *Dimetrodon;* and so are the teeth on the vomer in *Empedocles*. There is also a possible existence of epiphyses, judging from various specimens of humeri in my possession of both *Pelycosauria* and Stegocephalous forms.

In spite of these approximations, the *Pelycosauria* are distinctively rep-

* This word was misprinted "fossa" l. c. p. 529.

tilian in their single occipital condyle, ossification of the basicranial cartilage, and single vomer.

Thus the reptiles and batrachia of the Permian period resembled each other and the *Mammalia*, more closely than do the corresponding existing forms.

PELYCOSAURIA.

THEROPLEURA Cope.

Paleontological Bulletin No. 29, May, 1878, p. 519, Proceed. Amer. Philos. Soc., 1878, p. 519.

A more complete specimen of the *Theropleura uniformis* than any hitherto obtained gives the following generic characters.

The teeth are generally similar to those of *Clepsydrops* and *Dimetrodon*, having compressed crowns with fore and aft cutting edges. The incisors are distinguished by the presence of a diastema. Posteriorly to this the teeth increase in size, and then diminish; one tooth near the middle of the series is the largest, but does not in this species very much exceed the others. There is at least one large incisor tooth. The bones of the head are smooth, and not sculptured; a character distinguishing the genus from *Ectocynodon*. The symphysis of the mandible is short.

The neural arches of the vertebræ are all distinct from the centra. Intercentra are not present in any of the thirteen vertebræ preserved, but there was probably one below the centrum of the atlas. The ribs are two-headed, the capitular process extending downward to the anterior border of the centrum. The neural spines of some of the vertebræ are greatly elevated as in the species of *Clepsydrops* and *Dimetrodon*. The scapula is long; the ilium is similar to that of the genera named. A character which has not been detected in either of the genera named is the presence of dermal rods, which from their position adherent to the vertebræ, I suspect to be abdominal, and similar to those of the genus *Oëstocephalus*. This is a batrachian character. The neural spine of the axis is extended fore and aft. The odontoid is distinct and is of large size. It has lateral and inferior articular surfaces.

THEROPLEURA UNIFORMIS Cope.

Paleontological Bulletin No. 29, p. 519, 1878.

This species is about the size of one of the larger *Varanidæ*, and about equal to the *Clepsydrops natalis*. It is characterized by a long and acuminate head, with a large lateral nostril on each side, well forwards, and approaching near the border of the diastema. In the specimen the top of the head is crushed and the postorbital portion is wanting. Anterior to the large lateral tooth there are nine teeth; posterior to it there are eighteen. The anterior cutting edge of the crown does not extend so near the base as the posterior, and is best marked on the anterior teeth. In the crowns preserved the edges are not serrate.

Measurements.	M.
Length of alveolar edge of mandible	.120
" from diastema to canine tooth	.030
" of centrum of atlas	.010
" " " " axis	.018
" " centra of following five vertebræ	.071
" " ilium at acetabulum	.040

The lanciform shape of the skull with its consequent peculiarities distinguishes this species from the *Clepsydrops natalis*, and the *Dimetrodon incisivus*. The canine tooth is more posterior, the teeth more numerous, and the alveolar borders less curved than in either of those species. The diastema is less excavated, and the muzzle less obtuse.

THEROPLEURA OBTUSIDENS, sp. nov.

This species is represented by nearly all parts of the skeleton, including jaws of both sides with teeth, numerous vertebræ, and bones of the limbs. Many of these pieces are preserved in continuous masses, thus greatly aiding in the identification of parts.

Although the species is not larger than the *Theropleura retroversa*, the neural arches are coössified with the centrum.

The jaws are long and rather slender, and there is no such inequality in the sizes of the maxillary teeth as in the genera *Dimetrodon* and *Clepsydrops*; the canine being scarcely larger than the others. The crowns are elliptical in section at the base, with straight sides; the sections of the crowns are lenticular, and the apices are not very acute. The superficial coating is striate with fifteen or sixteen rather obtuse ridges. The cutting edges are not very acute, nor are they denticulate. The number of teeth in the dentary bone cannot be precisely stated, but is about twenty-one.

The mandibular articular face consists of two open parallel grooves, one shorter than the other, extending obliquely to the long axis of the jaw. The palatal dentigerous bone is quite different from that of *Dimetrodon*. Its inferior face instead of being narrow, is rhombic. The ascending process arises from one of the terminal angles of the rhomb, and the horizontal process continues from the opposite angle in line with the inferior surface. The borders of the rhomb next to the ascending process are dentigerous; the one bears a single series of four large teeth; and the adjacent angle and side bear numerous small teeth.

The vertebræ have the elongated neural spines of the allied genera, and they are simple. The centra have curved articular margins indicating the presence of intercentra, which are, however, not preserved. Traces of sutural articulation with the neural arch remain. Many of the centra are much compressed and have a narrow sharp median keel. In a few vertebræ, apparently from the posterior part of the column, an angular ridge extends posteriorly from the base of the diapophysis; this is apparent also on a caudal centrum. This point is characteristic of the *T. retroversa*, but I do not find the large capitular facet of that species in the *T. obtusidens*. The

lateral ridges of *T. triangulata* are situated low down on the centra. The diapophyses supporting the tubercular articulation are frequently elongate.

The scapular and pelvic bones are of the usual type. The humeri belong to form second of my Pal. Bull. No. 29. They have rather slender shafts, and much expanded extremities. The proximal articular surface is well defined. The supracondylar foramen and other points are as in the *Pelycosauria* generally. There were probably distal condyles, but this is not absolutely certain.

Measurements.			M.
Length of mandibular series of teeth (nearly complete), on block			.110
Length of crown of mandibular tooth			.008
Anteroposterior diameter of mandibular tooth			.004
Diameters of articular extremities of a vertebra on the same block	vertical		.021
	transverse.		.020
Length of another centrum on same block			.020
Diameters of humerus (separate)	of head	larger	.065
		smaller.	.013
	of shaft		.017

The above description represents the parts which belong either certainly or very probably to one individual. Bones of a second and larger animal are mingled with these. The species to which they belong is uncertain, but they resemble very much those of the *Theropleura obtusidens*, and may belong to a larger individual of that species. A femur has the form already described under the head of *Clepsydrops natalis*. (Paleontological Bulletin, No. 29, p. 510.) Some phalanges belonging no doubt to one or the other of the two animals, are like those I have already ascribed to *Clepsydrops*. They are depressed, and are expanded at the articular extremities. The distal extremities expand the most abruptly, and their convex trochlear face is without groove or keel, and is more extended on the inferior than the superior surface.

DIMETRODON Cope.

Proceedings American Philosophical Society, 1878, p. 512.

The accession of a considerable amount of material representing this genus enables me to add important points to our knowledge of its osteology. The most noteworthy additions include the greater part of the skeletons of two individuals of *D. incisivus;* and vertebræ attached to the pelvis and femora of *D. gigas*. There are also vertebræ of several individuals of *D. cruciger*, and various parts of the skull of a species distinct from the *D. incisivus*.

In both specimens of *D. incisivus*, portions of the palatopterygoid arch are attached to the maxillary bone. One of these elements is an oval plate with a thickening of its inferior side, so as to bevel the long border farthest from the maxillary bone. The surface thus produced is thickly studded with small conical teeth irregularly disposed.

A second tooth-bearing element of the palate is adjacent to the last. It

is a massive plate, the ends of which are produced in opposite directions; the one into a massive shorter prominence; the other longer and plate-like. Between these prolongations, the inferior edge of the bone bears a single row of well developed teeth. The patch of small teeth first described, commences at the extremity from which the longest process rises on the opposite side of the series of large teeth. This Z-shaped bone is, from its massive character, generally preserved, and I was long familiar with it, before I could refer it to its position. In one specimen, a part of it bearing teeth, adheres to the upper jaw at the diastema.

The posterior part of the skull of one of the specimens above mentioned displays typical reptilian characters. The occipital condyle is not perforated, nor divided by sutures. The exoccipital bones project well backwards. The lateral walls of the brain-case are massive as far forward as the exit of the fifth pair of nerves; anterior to this point they were thin or wanting. The basisphenoid carries two parallel descending laminæ, which bound a deep median fissure, and then unite anteriorly. Posteriorly they abut on a descending process, which is followed by a lid-like element which is applied to a circular fossa with a raised border near the occipital condyle.

The articular face of the articular bone of the mandible consists of two parallel cotyli, divided by a ridge of articular surface. This part of the jaw is much depressed, as in *Eryops*. The large teeth of the lower jaw are at the anterior extremity.

The neural spine of the axis is flat and elongate antero-posteriorly. From this point the neural spines rise rapidly in elevation until on the dorsal region they are many times as long as the diameters of the centra. The latter are not very unequal in their proportions in different parts of the column. Those from the posterior regions are less compressed than the dorsals and cervicals. The dorsals are separated by intercentra below, which are small in the *D. incisivus*, and larger in the *D. gigas*. All the ribs are two-headed, commencing with the axis. All the cervical and dorsal vertebræ have diapophyses with tubercular facets. The head of the rib is prolonged downwards and forwards to the prominent border of the anterior articular face, against which it abuts, but so far as yet observed, without a corresponding facet. On the caudal vertebræ the two facets of the ribs are approximated and finally are not distinguished. They are here coössified with the centra.

The humerus accompanying one of the specimens of *D. incisivus*, is of the form No. 3, of my description of humeri in the Paleontological Bulletin No. 29, p. 528. The extremities are expanded and the shaft is without diagonal ridge; the supracondylar foramen is enclosed, and the condyles are robust. The pelvis of the *D. gigas* is in general like that of *Clepsydrops natalis* (l. c., p. 510). The elements are coössified, but the ischiopubic symphysis is not so deep as in the *Batrachia* of the same beds. The ilium is shortened above, and its direction is at right angles to the long axis of the inferior elements. The foramen of the internal femoral artery is distinct. The femur of the

same individual of *D. gigas* has no head, but a regular wide crescentic proximal articular surface. Below this on the posterior side is the large trochanteric fossa, which is bounded by lateral ridges, which are at first equal, but one soon exceeds the other in height, forming a trochanteric ridge a little above the middle of the shaft. The condyles are distinct from each other and are flattened below. One of them bears a robust longitudinal crest above, which makes it much larger than the other, and causes the groove that separates them above, to look outward, or to the side which supports the trochanter.

Three of the species may be distinguished as follows:

Vertebral centra much compressed, acute below; neural spines without processes.....*D. incisivus.*

Vertebral centra less compressed, obtuse below; neural spines without processes; larger.....*D. gigas.*

Vertebral centra compressed, not acute below; neural spines with cross projections.....*D. cruciger.*

DIMETRODON CRUCIGER Cope.

American Naturalist, 1878, p. 830.

This species is not uncommon in the Permian Formation of Texas. It is characterized by the enormous length of the neural spines of the lumbar vertebræ, which form the dorsal fin seen in other species of the genus. They are found in masses adhering together like sticks or branches of bushes. In this species the spine sends off, a short distance above the neural canal, a pair of opposite short branches, forming a cross. At various more elevated positions there are given off tuberosities which alternate with each other. They form on several consecutive spines oblique rows. The spines are broadly oval in section, the long axis antero-posterior, and have a shallow groove on both the anterior and posterior aspects. The centra are elongate as compared with their other diameters, and are much compressed between the articular extremities, leaving a strong inferior median obtuse rib. Articular faces of zygapophyses oblique. Diapophyses short and robust, with large costal faces, and standing below the prezygapophyses.

Measurements.		M.
Diameter of centrum	antero-posterior	.043
	vertical at end	.028
	transverse at end	.030
Elevation of posterior zygapophyses above centrum		.025
" cruciform process " "		.058
Expanse of posterior zygapophyses		.034
" cruciform process		.048
Diameter of spine at base	antero-posterior	.030
	transverse	.020
" " .090 above base	antero-posterior	.016
	transverse	.016
Length of several pieces of neural spines		.140

DIADECTIDÆ.

I have obtained three skulls of the *Empedocles molaris*, a species of this family, which display the occiput, and two of them the basis of the cranial and facial regions. From them I derive the following characters.*

The relations of the quadrate and zygomatic arches are as in the *Theromorpha* generally. The pterygoids extend to the quadrates, and the vomer bears teeth. The brain-case extends to between the orbits, and its lateral walls are uninterrupted by fissures from this point to near the origin of the *os quadratum*. There is an enormous frontoparietal foramen. The mode of connection with the atlas is peculiar. There is a plane facet on each side of the *foramen magnum*, which then expands largely below them. The bone which bounds it inferiorly, presents on its posterior edge a median concavity. On each side of this, is a transverse cotylus, much like those of an atlas which are applied to the occipital condyles of the *Mammalia*. They occupy precisely the position of the Mammalian condyles. The median point of their upper border, which forms the floor of the foramen magnum, is produced in the position occupied by the median occipital condyle of a reptile. From its position between the cotyli, the section of this process is triangular. The element in which the cotyli are excavated has the form of the mammalian basioccipital, and of the reptilian sphenoid. It is not the batrachian parasphenoid. Its extreme external border on each side where it joins a crest descending from the exoccipital, is excavated by a circular fossa which looks outwards.

The character of this articulation is so distinct from anything yet known among vertebrated animals, that I felt justified in proposing (l. c., p. 304) a new division of the *Theromorpha* to include the *Diadectidæ*, to be called the *Cotylosauria*. The superior facets described, indicate the presence of atlantal zygapophyses as in the *Ganocephala*.

There are three genera of *Diadectidæ*, one of which is now introduced for the first time. They are distinguished as follows :

I. Molar teeth in one series ;
  A distinct canine..... ..... *Diadectes.*
  No canine..... *Empedocles.*
II. Molar teeth in two series ;
  A canine..... *Helodectes.*

I am acquainted with six species of this family, two of each of the genera.

DIADECTES Cope.

Proceeds. Amer. Philos. Society, 1878, p. 505. American Naturalist, April 22, 1878.

The typical species of the genus has compressed teeth, with one end of the crown much more elevated than the other. In the lower jaw the inner extremity is the elevated one, and *vice versa*. There is a large tooth in the position of a canine in the inferior series, but it is not certain whether or not it is an incisor. A new species is now described which is intermediate

*These were first described in the American Naturalist, 1880, p. 304.

between the *D. sideropelicus* and the *Empedocles molaris* in the form of the molar teeth. The species are distinguished as follows:

Much inequality in the elevation of the extremities of the molars; lower tubercle small ..... *D. sideropelicus.*

Extremities of molars not very unequal in height; lower tubercle large..... *D. phaseolinus.*

DIADECTES PHASEOLINUS Cope. sp. nov.

This species is represented in my collection by the maxillary bones of three animals, and a portion of the mandible with most of the tooth line of a fourth. These fragments are of about the size of the *D. sideropelicus* and *Empedocles molaris.*

The molars possess a low cusp which is nearly in the middle of the tooth. Of the lower and external cusps, the internal is the wider and more rounded; when unworn it is as elevated as the external, but it is soon reduced by attrition. The external part of the tooth is somewhat narrowed, and there is no horizontal surface on either side of the median cusp, as in *Empedocles molaris.* The last maxillary tooth is rather small; preceding it are eight wide transverse ones, and then two less extended transversely before reaching the broken end of my best specimen. The anterior of these is elongate, and may be caniniform, but its apex is lost. External layer smooth; some wrinkles round the base of the median cusp.

The broken base of the molar bone is subround and small, and shows that that element is slender below the orbit.

The portion of mandible preserved is quite deep, and is incurved at the symphysis. But few of its teeth are preserved, and it is not possible to say how long the anterior ones with subround bases may have been. The molar whose crown is preserved does not differ materially from those of the maxillary series. The alveolar line does not retreat inwards from the external border as in *Empedocles latibuccatus*, resembling in this respect the *D. sideropelicus.* The external surface of the lower jaw is roughened by shallower and deeper small or minute pits closely placed.

Measurements.	M.
Length of series of eleven maxillary teeth.....	.075
Length of series of seven widest molars.....	.048
Diameter widest molar { anteroposterior.....	.006
Diameter widest molar { transverse.	.016
Depth of mandible externally.....	.050
Width of mandible at middle.....	.026

It is possible that it may yet be necessary to refer this species to *Empedocles.*

EMPEDOCLES Cope.

Proceedings Amer. Philos. Soc., 1878, p. 516. American Naturalist, April 22, 1878; April, 1880.

I am acquainted with two species of this genus, *E molaris** and *E. lati-*

* *Diadectes molaris*, Amer. Naturalist, 1878, p. 565.

buccatus.* The latter is represented by portions of two mandibles in my collection; the former by two or three skulls, with part of the mandible accompanying one of them. The difference in the forms of the mandibles is well marked. In *E. molaris* the dental series is parallel to the external border of the jaw; in *E. latibuccatus* the tooth line is deflected inwards from the border, leaving a wide space.

Empedocles molaris Cope.

Diadectes molaris Cope. American Naturalist, 1878, p. 565.

The molar teeth are wider in this species than in any species of the family yet known. The internal and external extremities of the crown are about equally wide and equally elevated, and there is a low median cusp. A portion of the grinding surface both internal and external to the cusp is horizontal; the surface of this portion is wrinkled. The last molar is smaller than the others. The inner border of the maxillary bones forms a curved ridge on each side of the palate, which is separated by a groove from the vomer. The latter forms a median keel at the anterior portion of the palate, where it supports two rows of small conical teeth. The palatines have their prominent internal edges juxtaposed as far as the transverse line of the last molars. There they diverge a little, and extend as two nearly parallel keels to a prominent angle on each side, opposite the middle of the zygomatic foramen. There the inner borders cease to project, and are directed obliquely outwards to the inner extremities of the quadrate bones. The external borders of the pterygoids are more elevated than the internal. The median keel of the basisphenoid arises between the internal angles of the pterygoids above mentioned, and ceases before reaching the inferior border of the occipital condyle. The external border of the exoccipital is sigmoidally flexed.

It has occurred to me that the peculiar condition of the occiput described under the head of the family *Diadectidæ*, may be due to the loss of the basioccipital bone. It would be a remarkable coincidence if this accident should have befallen the only three crania which have come into my possession.

The anterior border of the orbit is above the anterior part of the fourth molar, counting from behind. The distinct incisive foramina are longitudinal and rather large. The anterior border is opposite to the fourth tooth counting from the first incisor. The nostrils look out laterally and a little forward; the united spines of the premaxillaries form a stout septum. The incisors are not more than three or four on each side (I cannot find the premaxillo-maxillary suture), and they form a regularly convex series. With the maxillaries, the entire dentition of one side forms a gentle sigmoid curve. The median incisors are the largest; the sizes regularly diminish until the smallest are reached on the anterior part of the maxillary bone. Posterior to this point they enlarge again. Their apices are not preserved.

* *Diadectes latibuccatus*, Proceed. Amer. Philos. Soc., 1878, p. 505.

The superior surface of the skull is only partly preserved in one specimen. This renders it probable that there is a crotaphite foramen as in the crocodiles, etc. The surfaces of the external cranial elements are finely pitted, or rather punctured.

Measurements.	M.
Total length of skull	.180
Width of skull at quadrates	.145
" " " origin of zygoma	.115
" " " incisive foramen	.056
Length of dental series to posterior extremity of incisive foramen, on curve	.090
Diameters of third molar from behind { anteroposterior	.010
Diameters of third molar from behind { transverse	.021
Depth of mandible at fifth molar from behind	.048

Maxillary series of seven, and parts of the mandibular series of four, individuals, are in my collection.

HELODECTES Cope. Genus novum.

Maxillary bones of two species, which I refer to this genus, were found associated with many bones of appropriate size, among which are vertebræ of the type of *Empedocles*. The characters observable are generally similar to those of the *Diadectidæ*, where I accordingly place the genus. Its principal characters, the presence of two rows of teeth in the jaws, has already been pointed out. I may add that there is apparently a large tooth in the position of anterior incisor, in the typical species.

The species differ in the arrangement of their teeth, as follows :

Molar teeth of the two rows subequal in size, and equally numerous ..... *H. paridens.*

Molar teeth of one row wider, and more numerous than those of the other ..... *H. isaaci.*

HELODECTES PARIDENS Cope. Sp. nov.

The smallest species of the family, is of about half the linear dimensions of the *Empedocles molaris*. It is represented by a left maxillary and probably premaxillary bone, which are so far covered with the adhesive, hardened ferruginous mud of the formation, as not to expose a clean surface. The apices of all the teeth are broken off, so that the bases alone remain to indicate their number, form and positions.

Of the molar teeth proper I count six in the inner, and eight in the external row. The two series are close together, and are gently convex inwards. The bases of the teeth are wide ovals, transversely placed. In front of the eighth tooth of the external row (from behind), are two teeth without apparent mates of the internal row (possibly the latter lost). Then follows a tooth of each row, and in front of these another pair, the external being the larger. Anterior to these, the jaw is so split as to remove any teeth of the inner row, if there are any, and one large tooth of the external series stands at the extremity of the fragment. This latter exceeds the

other teeth in the length and diameter of its basal portion. From its position it is probably an incisor.

The anterior border of the orbit falls above the third tooth of the external row (counting from behind). The inner border of the maxillary bone is elevated into the ridge convex inwards, as in the other species of this family. The malar base of the zygomatic arch is a moderately stout vertical oval.

Measurements.	M.
Length of dental series	.062
Length of molar 6-8 series	.029
Width of the two molar series	.009
Vertical diameter malar bone	.013

The associated bones of the skeleton may belong to this or to the next species, or even to a small *Empedocles* whose teeth occur in the same lot. In the uncertainty of reference I do not describe them.

HELODECTES ISAACI Cope. Sp. nov.

Founded on a fragment probably of a maxillary bone, lacking both extremities, and considerably obscured by ferruginous deposit.

The characters are well marked, leaving no doubt that this species is distinct from those previously known. The bases of the teeth of one of the rows are much more extended transversely than those of the other, having the form of some of those of *Empedocles*. As in that genus, they shorten anteriorly. In the fragment, I count on this row, bases of nine teeth. In the other row, I can only definitely count three, which are opposite the second, third, and fourth of the other series (counting from behind). They are wide transverse ovals, about half the long diameter of the posterior teeth of the other series.

Measurements.		M.
Length of bases of eight larger molars		.032
Diameter of large molar	anteroposterior	.004
	transverse	.008
Length of three smaller molars		.012
Long diameter of a smaller molar		.004

This species is dedicated to J. C. Isaac, the discoverer of the first species of this family.

GANOCEPHALA.

Examination of abundant material shows the correctness of my anticipation (American Naturalist, 1878, 633), that the vertebræ of the large batrachian *Eryops*, would turn out to have the structure found in *Rhachitomus*. This genus then must be referred to the same sub-order as *Trimerorhachis*, and probably *Actinodon* Gaudry, which will be characterized by the segmented vertebral centra. If European authors are correct in stating that the vertebræ of the *Labyrinthodontia* have undivided centra, the sub-order above mentioned must probably retain the name of *Ganocephala*, with additional characters.

The identification of the scapular arch in *Eryops*, and of the pelvic arch

in *Eryops* and *Cricotus*, gives the following result: The glenoid cavity is an excavation in two coössified elements, of which the inferior and posterior is probably coracoid. The latter is then much smaller than in *Reptilia* and *Batrachia anura*, but resembles that of the salamanders. The scapular arch proper resembles that of the *Urodela*. The pelvis is intermediate between that of the anurous and urodelous *Batrachia*. There is no obturator foramen, and the common symphysis is deep. The humerus closely resembles that of the *Pelycosauria*, differing chiefly in the non-enclosure of the supracondylar foramen; and as in that sub-order, some genera possess condyles and some do not.

Prof. Owen proposed the order *Ganocephala* chiefly for *Archegosaurus*, but he included in it also the genera *Denderpeton* and *Pelion* (Paleontology, p. 182–3). This division has not been generally adopted, the genera mentioned being usually placed in the *Labyrinthodontia*. Of the eleven characters given by Prof. Owen in evidence of the existence of this order, one only does not belong also to the *Labyrinthodontia;* this is the absence of occipital condyles. On this account I thought that the group should be retained, but not as an order. Besides this group and the *Labyrinthodontia*, there were the types called *Microsauria* by Dawson, some of which have simple enamel, all agreeing in general characters, and differing from other Batrachia. I therefore combined the three groups into one order, the *Stegocephali*. (Proceedings, Academy, Philada., 1868, p. 209.) This order was most distinctly characterized in the Report of the Geological Survey of Ohio, Paleontology, ii, p. 354, 1875.

Von Meyer has given us enough of the characters of *Archegosaurus* to enable me to refer the forms of the Texan Permian to the same order. Prof. Owen, in his discussion of the affinities of that genus (l. c., p. 170), remarks, that the vertebræ and numerous very short ribs, with the "indications of stunted swimming limbs, impressed me with the conviction of the near alliance of the *Archegosaurus* with the *Proteus* and other perennibranchiate reptiles." As it is now well known that perennibranchiate batrachians belong to three different orders of the class (*Trachystomata*, *Proteida* and *Urodela*), the above expressions lose point, and especially as the characters mentioned as indicative of affinity are of the most subordinate importance, or as in the structure of the vertebræ, are totally distinct from what is found in those orders. When we read later (p. 173), that the fact that the superior "ossifications of the skull have started from centres more numerous than those of the true vertebral system, gives the character of the present extinct order of *Batrachia;*" we find that Prof. Owen has quite failed to perceive either the definitions or affinities of his new order. He commits an error in describing a distinct pubic bone; an element which Von Meyer states (Paleontographica, vi, 179, 1858) that he had not discovered. Von Meyer describes the coössified inferior elements of the pelvis as ischia. My numerous Texan specimens show that each of these bones includes both pubis and ischium.

In now defining the *Ganocephala* anew, I confine myself to characters

which I know to be common to the known genera. Some of them possess two occipital condyles. For the purpose of avoiding the multiplication of synonymes, I employ Prof. Owen's name.

Vertebræ consisting of centra and intercentra, the former not extending to the base of the vertebra, the latter not rising to the neural canal. The centrum consisting of two parts distinct from the superior neural arch; viz., a lateral piece (pleurocentrum), on each side. Atlas consisting of separate segments, the superior of which are not united above the neural canal, and the inferior (intercentrum) divided on the middle line, into two segments.

Genera. *A.* Basioccipital bone without condyles: *Trimerorhachis* Cope; *Archegosaurus* Meyer. *A. A.* Basioccipital condyles two: *Actinodon* Guadry; *Rachitomus* Cope; *Eryops* Cope.

All the above genera have well-developed neural spines except *Trimerorhachis.*

ERYOPS Cope.

Paleontological Bulletin No. 26, p. 188. Nov. 21st, 1877. Proceedings Amer. Philos. Society, 1877 (1878), p. 188.

In the essay above cited, the cranial characters of this genus were pointed out with some of those of the vertebræ. It remains to describe the other parts of the skeleton. Notices of some of these have already appeared in the American Naturalist for September, 1878 and May, 1880.

The largest element of the vertebra is the intercentrum. This, which occupies the entire inferior surface of the vertebra, is a segment, representing the sixth part of a sphere, with a slight central vacuity. The element representative of the centrum is wedged in between the superior external angles of adjacent intercentra, as in *Trimerorhachis.* These, as well as the intercentra, differ from those of that genus in their greater degree of ossification, which is so far complete as to greatly contract the *canalis chordæ dorsalis.* The central elements of opposite sides do not unite on the middle line below, although in contact. The neurapophysis is produced downwards and outwards, terminating in the simple diapophysis, with rib articulation. The inferior articular faces of the arch are two on each side, one for the central element in front, and the other for the one behind it. The whole is surmounted by a continuous neural spine, which is expanded at the summit, in the known species. The vertebræ do not differ much in different parts of the column. The cervicals are not distinguished in any way from the dorsals, but their anterior intercentra have more extensive costal surfaces, which give the inferior posterior border lateral angles. The diapophyses of the second and third cervicals are of reduced size. The neural spine of the axis is a little less elevated, and is longer anteroposteriorly than that of the third and succeeding cervicals. I do not possess an entire atlas free from matrix. Attached to the axis of this specimen are two elements which connected it with the skull, as they are separated from it only by closely fitting fractures. The elements are lateral, and each presents a semi-spherical articular face in front, and a long process with acute apex at right angles to it, posteriorly. These processes lie, one on each

side of the neural spine of the axis, above the position which would be occupied by its prezygapophysis ; they represent the distinct halves of the arch of the atlas. At the superior base of each process near the edge of the articulation is a button-like tubercle, which represents a prezygapophysis ; the inferior articular faces correspond with those of the occipital condyles in form but not in position, which is inverted. The inferior elements of the atlas are lost.

The intercentra are rather longer and more elevated in the sacral region. One only can be properly said to belong to the sacrum, and this is closely united with the one that follows it by a rough surface of contact. In old animals it may become coössified. What the relations to the intercentrum immediately preceding may be I am unable to state, owing to the condition of the specimen. A pair of caudal vertebræ are peculiar. Their intercentra are in contact throughout, excluding the pleurocentra. The latter rest above the intercentra, and between the inferior parts of adjacent neural arches. Each intercentrum supports a coössified chevron bone, and these, in the two vertebræ in question, become coössified with each other, forming a robust rod directed backwards, whose double base is perforated by the hæmal canal. This peculiar structure probably belongs near the extremity of the caudal series, as the anterior caudals observed in other specimens, are much like the dorsals.

The costal articulations are everywhere undivided, and have an obliquely vertical extension. The articular surface extends to the intercentrum in the *E. megacephalus*, forming a short superficial depression which enters from the supero-posterior border. The costal surfaces of the diapophyses become more robust anteriorly, and are more narrowed, especially at the middle and inferior portions, posteriorly. The diapophysis of the sacral vertebra is very robust, and presents a large tubercular face downwards, and a little backwards. The external side of the intercentrum about its superior angle is also covered by a large capitular facet, and the two facets support a sacral rib. This element is much more robust anteriorly than the true ribs, and its capitular and tubercular facets are distinct from each other, although they are separated by but a slight interruption. The body of the rib is plate-like, and is directed downwards and backwards, its union with the ilium being squamosal. The costal elements posterier to the sacrum diminish rapidly in size. From the size of the vertebræ in *E. megacephalus*, the tail is probably of medium length only.

The coracoid is but little incurved ; its internal border is convex, and is roughened as though for cartilaginous attachment. Its superior portion forms a convex continuum with the scapula. The direct line or external face of the scapula extends in a nearly plane surface to the glenoid cavity, embracing a perforating foramen above the latter, precisely as in the *Pelycosauria*. Its surface is continuous anteriorly with a wide expansion forwards, whose fine inner border is continuous with that of the coracoid. This plate doubtless includes a third element, but its borders are not preserved, on account of the obliteration of the sutures. It is probably epicoracoid, as in the *Pelycosauria*. In its form it is less produced than in the known scapular arches of the latter.

The coössified pelvic elements resemble, in their compression below, the corresponding parts in the *Anura*. The ilia are, however, shorter and worn as in the *Urodela*. They are flat, and stand at right angles to the line of the ischiopubic symphysis. There is an open concavity of their inferior posterior free border, and a facet-bearing elevation on the inferior border, or that entering into the formation of the acetabulum. The latter is large and half as long again as deep. The anterior and posterior borders of the pelvis descend regularly to the inferior edge, forming with it a triangle. The ischiadic or posterior border is but little thickened; the anterior, or pubic is flat in front and presents a reverted edge outwards. This expands prominently where it is joined by a ridge which bounds the acetabulum below; it there contracts to an inferior apex. Beneath the anterior point of the acetabulum it is pierced by the usual foramen, which issues on the inner edge of the anterior face, just above the symphysis.

The humeral bones of this genus I probably possess; but I have several forms between which I am not able to decide. They are in general like those of the *Pelycosauria*, but differ from them in not having an enclosed supracondylar arterial foramen, but only the buttresses of its enclosing arch. Two such forms I have already described,* and a third has been obtained from the French Permian by Professor Gaudry. One quite similar to the latter I have since obtained from Texas. Not having been able at first to determine the proper reference of these humeri, I suggested to Prof. Gaudry that his humerus belongs to one of the *Pelycosauria*, and he accordingly described it as *Euchirosaurus rochei*.† I now think that there is greater reason for believing that it belongs to a species of the same group as *Eryops* and *Actinodon*.

In all these humeri the extremities are expanded in different planes, and the shaft contracted. The articular surface of the proximal extremity is band-like and passes obliquely from one side to the other as in the *Pelycosauria*. The condyles are large, consisting of a globular portion and a depressed trochlea without ridges at one side of it.

The femora are very different from the humeri, but in much the same way as in the corresponding bones of existing *Batrachia*. There are no condyles at either extremity, but outlines of such, enclosing roughened surfaces. These look as though the bases of attachment of cartilaginous caps or epiphyses. The proximal extremity is convex, and is extended in one direction. One border, the anterior, is regularly gently convex; the opposite arc is strongly convex near one end only. The articular face is in two planes, one larger than the other. The trochanteric fossa is at first shallow, and occupies the entire width of the bone, it narrows with the shaft downwards and the borders rise, one more than the other. The two join in a strong protuberance, which looks directly backwards, and may be called for the present the third trochanter. The shaft is keeled below and in continuation of the trochanter, to where it expands for the distal articu-

* Paleontol. Bulletin, 29, 1878, p. 529.

† Bulletin Soc. Geol. France, Dec., 1878.

lar extremity. The latter looks partly downwards, and is divided by a deep groove above into two parts representing the usual condyles. One of these is comparatively depressed, while the other has a massive superior crest, which makes its long axis vertical instead of horizontal, as is that of the other condyle.

There is considerable resemblance between this femur and that of *Dimetrodon gigas*, and in a less degree to that of *Clepsydrops natalis*, but both the latter have well developed condylar surfaces. They are also larger in proportion to the size of the rest of the skeleton, in the *Pelycosaurians* mentioned.

Further characteristics of this genus and of the species it embraces will be given at a future time.

TRIMERORHACHIS Cope.

American Naturalist, 1878, p. 328 (April 22). Proceedings American Philos. Society, 1878, p. 524.

This genus, as has been pointed out, differs from *Eryops* in the superficial character of its vertebral ossifications, and in the absence of ossified neural spines.

A well-preserved cranium, and portions of several others referable to this genus, furnish characters which have been hitherto inaccessible. They probably belong to the *T. insignis*, but this is not certain.

Generic Characters, etc.—The type of skull is that of the order of *Stegocephali* generally. The superior walls are thin, and are sculptured on the superior surface. The mucous grooves are distinct, but do not form a well-defined lyra. There is a groove which is parallel to the anterior borders of the orbit for a short distance, and which then turns forwards and then inwards. The dermal ossification is distinguished from that of the maxillary bone by a squamosal suture. A mucous groove descends to it obliquely forward from the superior quadrate region, and sends a branch at right angles to its anterior extremity to a point posterior to the orbit. Of superficial ossifications, the boundaries are difficult to determine, owing to the obscurity of the sutures. Enough can be seen to demonstrate the presence of supramaxillary, epiotic, and supraoccipital dermal bones. The nostrils are large and well-separated, and look upwards.

The teeth are acute, and of subequal size; their superficial layer is deeply inflected at the base.

The parasphenoid bone is wide posteriorly, but contracts abruptly, and extends forwards on the middle line. Owing to crushing of a part of the surface, I am unable to ascertain its anterior, or vomerine suture. The basifacial axis bone is quite narrow, and is edentulous. It is connected with the superior cranial walls by a vertical osseous plate on each side, which may represent alisphenoid, orbitosphenoid and ethmoid. The palatopterygoid arch is a longitudinally extended sigmoid, enclosing with the axial elements, an enormous choanoörbital foramen. It extends from the middle line below a short distance posterior to the position of the nostrils

outwards, and follows closely the maxillary bone well posteriorly. It then turns inwards, extending to the parasphenoid bone, with the wide portion of which it has an extensive contact. It then turns outwards as pterygoid bone, and rapidly narrowing, joins the inner distal extremity of the quadrate. It thus encloses a foramen with the quadratojugal bone, which is much smaller than the choanoörbital foramen. The posterior part of the inferior surface of the bones of this arch, not including the slender pterygoid portion, is roughened with hard nodules resembling teeth in material, and serving the purpose of such organs.

Two rod-like bones extend outwards and backwards from the posterior part of the parasphenoid and the basioccipital, which belong to the inferior arches. The anterior is the larger, and is bent backwards at an obtuse angle; its proximal extremity is a truncate oval. This bone occupies the position of the stapes. The second is extensively in contact with the basioccipital by its proximal extremity. It is curved backwards at its distal third. The occipital condyle is represented by a fish-like cotylus, which has a deep notch at its superior border.

The mandible has a short angular process, vertical by lateral compression. The symphysis is very short and the Meckelian cavity large, and completely enclosed.

The anterior cervical vertebræ consist of the same elements as the dorsals. The intercentra of the second and third vertebræ support capitular costal articulations, somewhat elevated above the surrounding level. The pleurocentra do not support the ribs, but the neural arches terminate below in diapophyses. There is a pleurocentrum in front of the second intercentrum, and above and in front of it a neurapophysis, which has no distinct diapophysis. Its superior portion is a subacute process which is not in contact with that of the other side, but is separated from it by a vertical osseous plate, which is probably the neural spine of the second vertebra or axis. This is similar to the structure already observed in *Eryops*, and the parts being in place, should explain those of that genus. The portion of the atlas which represents the intercentrum is divided into two lateral portions, each of which has the form of an entire intercentrum, i.e., crescentic. The intercentrum of a cervical of a large species of this group, is wider than that of the other vertebræ, and presents two articular facets anteriorly.

Specific Characters.—The skull is flat and rather wide, the length exceeding a little the transverse posterior diameter. The posterior borders of the orbits mark a point half way between the extremity of the muzzle, and the posterior supraoccipital border. The orbits themselves are of medium size, and are separated by a space about equal to their transverse diameter. Their form is a wide oval, with the long axis obliquely antero-posterior. The diameter of the external nostril is nearly half that of the orbit, and the form is similar to that of the latter. The interorbital and ethmoid regions are concave; the prefrontal regions are convex. The supraoccipital border is strongly concave; and the notch separating the epiotic angle from the quadrate angle is as deep as the supraoccipital. The

surface of the cranium is thrown into wrinkles which form no regular pattern, and which inosculate to a moderate extent, most so on the preorbital region. The anterior parts of the maxilliary and mandibular bones are marked with small pit-like impressions.

Measurements.	M.
Total length to quadrate angles measured on median line	.170
Length to supraoccipital border	.138
Total width posteriorly	.155
Width at orbits	.095
" between orbits	.021
" at nares	.062
" between nares	.030
Long diameter of orbits	.026
Transverse diameter of occipital cotylus	.012

This cranium is much shorter and wider than that of *Archegosaurus decheni*, and has the orbits more anteriorly placed.

CROSSOPTERYGIA.

ECTOSTEORHACHIS Cope, gen. nov.

Tribe *Crossopterygia;* family *Rhombodipteridæ* Traquair; sub-family *Saurodipterini* Huxley. Pectoral and ventral fins rather acutely lobate, with few or no radii on their external borders. Dorsal and anal fins unknown. Scales imbricate, rhombic, smooth. Ganoine wanting from top of head in specimens examined, but present on sides and inferior surfaces. Coronal suture distinct. End of the muzzle covered with separate scales. Distinct sub- and postorbital bones. Gular bones, an anterior azygus and two laterals on each side, the posterior the shorter. Teeth acutely conic, rather small; a few large ones at the anterior part of each jaw. Vertebral centra represented by osseous rings which enclosed a notochord.

This new genus is apparently nearly related to *Megalichthys*, and in a less degree to *Osteolepis* and *Diplopterax*. Pander, Miller and others represent the ventral fins of the two genera last named as not lobate, but sessile, a state of things entirely different from what is observed in *Ectosteorhachis*. The sub-division of the dermal bones of the muzzle is also rather characteristic of *Megalichthys*. From the latter genus it differs in the form of the vertebral centra. Both Agassiz and Huxley describe those of *Megalichthys* as completely ossified, and as biconcave. In *Ectosteorhachis* they are represented by annular ossifications resembling somewhat those of the stegocephalous genus *Cricotus*, but with a larger *foramen chordæ dorsalis*.

The elongate-lobate axis of the fins of this genus render it probable that those of *Megalichthys* present the same character.

ECTOSTEORHACHIS NITIDUS Cope, sp. nov.

This fish is represented by several specimens, the best preserved of which includes the head and body inclusive of the ventral fins. These form an ichthyolite nearly denuded of matrix, the inferior side being best preserved.

No indications of dorsal fin are to be found in the specimen, and those which exist must originate behind a point above the base of the ventral fins. The pectoral fins originate further behind the head than is usual. The ventrals are well posterior, and close together.

The skull is transversely fractured at the coronal suture, as I suppose it to be, which divides the front, just anterior to the point of attachment of the hyomandibular bone. At the antero external angles of the parietals, are distinct post-frontal bones of a sub-triangular form, which send a process posteriorly from their external angle. The hyomandibular presents a narrow convex external edge, and is directed backwards and downwards. It leaves a wide space posterior to the postorbital bones. Of the latter there are two, the inferior connected with the front of the orbit by a single wide, suborbital bone. The orbits are as much lateral as vertical, and are in front of a transverse line dividing the skull equally. The muzzle is broadly rounded, and is covered with rounded plates of ganoine. Several of these have median perforations. The opercular apparatus is obscured by matrix in the specimens; a small bone lies on the inferior part of the suspensorium on both sides, and may be the preoperculum. The top of the head behind the muzzle is entirely without ganoine layer in two specimens; its surface is smooth, or weakly finely ridged. On the other hand, the premaxillary, maxillary, mandibular and gular bones are invested with perfectly smooth ganoine.

The pectoral fins are quite wide, and their rays diverge exclusively from the inner border, and are very fine. The axial portion is thick and acuminate, and has no fulcra on the external edge, but is covered with quadrate and rhomboidal scales, of very much smaller size than those of the body. The axial portion of the ventral fins is not quite so large as that of the pectoral.

The scales of the body are quite large and overlap each other by both the free edges. Though their form is rhombic, the apex is rounded. The surface is ganoid, and entirely smooth. There are five rows between the internal bases of the ventral fins, and twelve between the external bases of the pectorals. The gulars of the posterior pair are about as long as those of the anterior. There are anteriorly one and posteriorly two rows of plates between the anterior gulars and the mandible.

This fish was probably three feet in length.

Measurements.	M.
Length of head to base of first distinct lateral body scale (posterior border of skull damaged)	.161
Length to base of pectoral fin	.180
" (axial) to canthus oris	.077
" of skull to coronal suture	.067
" " " anterior border of orbit	.021
Width " at " " "	.065
" of front between " " "	.036
" " at coronal suture	.029

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Measurements.		M.
Width of skull at canthus oris		.145
Length of inferior canine tooth		.006
Width between bases of pectorals		.092
Length of basal axis of pectoral		.060
" " " " ventral		.035
Width between bases of ventrals		.033
Diameters of exposed parts of an abdominal scale	fore and aft	.012
	longitudinal	.015

The *Megalichthys hibberti* Ag., which this species resembles in some degree, is represented by authors as having the scales minutely granulated on the surface. The ganoine layer also covers the superior surface of the skull, a peculiarity which is not present in the *Ectosteorhachis nitidus*.

EXPLANATION OF FIGURES.

Figure 1.—*Skull of Eryops megacephalus* from above, one-fifth natural size.
Fig. 2.—The same skull, profile.
Fig. 3.—The same from below.
Fig. 4.—Mandibular ramus from above, one-fourth natural size.
Fig. 5.—A large part of the vertebral column of a second specimen from the left side, one-fourth natural size.
Fig. 6.—The same from below.
Fig. 7.—Anterior view of atlas and axis, natural size.
Fig. 8.—Posterior view of a dorsal vertebra, natural size.
Fig. 9.—Inferior part of scapula with coracoid, of same animal, external side.
Fig. 10.—Same, interno-posterior view.
Fig. 11.—Pelvis of the same individual, left side.
Fig. 12.—Same, from front.
Fig. 13.—Same, from behind.
Fig. 14.—Same, from below.
Fig. 15.—Femur of same individual, from above.
Fig. 16.—Same, from below and behind.
Fig. 17.—Proximal end.
Fig. 19.—Distal end.
Fig. 20.—Inferior view of skull of *Empedocles molaris*, one-half natural size.
Fig. 21.—Posterior view of the same skull, half natural size.
Fig. 22–25.—Bones of *Dimetrodon incisivus*, one-fourth natural size, from a single individual.
Fig. 22.—End of muzzle, left side.
Fig. 23.—Lateral view of a large part of the vertebral column.
Fig. 24.—Thirteenth vertebra, lacking the summit of the neural spine, from behind.
Fig. 25.—Fourteenth vertebra, lacking apex of neural spine, from front.
Fig. 26.—Nineteenth vertebra of same skeleton, lacking most of neural spine, from behind, two-thirds natural size.
Fig. 27.—Sacrum of same from front, two-thirds natural size.

Stated Meeting, May 21, 1880.

Present, 7 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was received from Dr. Wm. Thomson, dated 1502 Locust street, Philadelphia, May 1, 1880.

Letters of acknowledgment were received from the Royal Observatory of Prag, dated April 24, 1880 (102, 103); Natural History Society of Newcastle-upon-Tyne, April 28 (103, 104); Brown University, in Providence, R. I., May 1 (105); Maryland Historical Society, Baltimore, May 11 (105); Smithsonian Institution, Washington, May 8 (105); U. S. Naval Observatory, Washington, May 10 (105); Hamilton College, Clinton, N. Y., May 8 (105); and the Davenport Academy of Natural Sciences, May 4 (105).

Letters of envoy were received from Hofrath Adam Freiherrn Von Burg, dated Vienna, January, 1880; the Society of Physics, Geneva, January 13; the Natural History Society, Marburg, January, 1880; and the K. Leopoldinisch-Carolinischen Akademie, Halle, a.-S. January 2.

A letter was received from Charles Kraus, dated April 26, 1880, Pardubitz-Bohemia, asking for the Proceeding of the year 1879.

A letter was received from the U. S. Naval Observatory, asking for Proceedings Nos. 5, 67, 68, 93. On motion it was referred to the Secretaries for action.

Donations were received from the Royal Society of New South Wales; the Observatories at the Cape of Good Hope, St. Petersburg, and Greenwich; Academies at St. Petersburg, Dresden, Dijon, and Brussels; Vereines zur Beförderung des Gartenbaues, Berlin; Anthropological Society, K. K. Geological Committee, and Hofrath Adam Freiherrn von Burg, Vienna; Editors of the Zoologischer Anzeiger, Leipsig; Royal Society, Göttingen; Zoological Gar-

den, Frankfurt, a.-M.; Editors of the Neues Lausitzisches Magazin, Görlitz; Natural History Society, Marburg; Physical Society, Geneva; Bureau des Longitudes, Society of Antiquaries, Annales des Mines, and Editors of the Revue Politique, Paris; Physical and Geographical Societies, Bordeaux; Editors of the Revista Euskara, Pamplona; Royal Institution, Royal Geographical Society, Meteorological Society, Editors of Nature, and Lords of the Admiralty, London; Glasgow Geological Society; Editors of the Canadian Naturalist, Montreal; Massachusetts Historical Society; Peabody Museum, and Museum of Comparative Zoölogy, Cambridge; Editor of the North American Entomologist, and Young Men's Association, Buffalo; Mr. Barclay and Mr. Henry Phillips, Jr., Philadelphia; the Bureau of Education, and Mr. Asaph Hall, Washington; Cincinnati Society of Natural History; State Historical Society, Madison, Wisconsin; Missouri Historical Society, St. Louis; and the National Museum, Mexico.

Mr. Henry Phillips, Jr., read a paper entitled, "Some recent discoveries of stone implements in Africa and Asia."

Prof. Cope made some remarks "On certain Tertiary Strata of the Great Basin."

In Vol I of the Report of the United States Geological Survey of the Fortieth Parallel, page 393, the able author, Mr. King, has described an extensive series of beds, including many laminated shales, which are found in the northern part of Nevada, as constituting an extension of the Green river formation west of the Wasatch mountains.* He states that they contain the same species of fossil fishes as those of the Green river epoch. I published the first notice of this formation, which I examined at Osino and at Elko, Nevada,† and described from it two species of fishes, which were referred to genera previously unknown, viz: *Amyzon* and *Trichophanes*. These genera have not been found represented in the fish fauna preserved in the Green river shales, which embraces eight genera and twenty-four species. But they occur in several species and specimens in the South Park of the Rocky mountains of Colorado, associated with the genera *Rhineastes* and *Amia*, neither of which has yet been found in the Green river formation. The first named is common in the Bridger, but in a different form, and the generic identity is not yet fully established. The *Amia* is

* l. c. I. p. 393.

† Proceedings Amer. Philos. Soc. 1872, p. 468.

represented in the Bridger by *Pappicthys*, but in the former genera the characteristic parts have not yet been seen in the South Park specimens, so that here also the determination of the genus is not final. It, however, remains that this fish fauna is different from that of the Green River beds, and the modern aspect of the genera points to an age even later than the Bridger. It is evident that the pertinence of this series of rocks to the Green River formation, asserted by King, cannot be maintained.

In the American Naturalist for May, 1879, I named the strata of this epoch that of the Amyzon beds, from the characteristic genus which it includes, and refer it to the later Eocene or early Miocene eras. Its fish fauna includes ten species, distributed, as follows : *Trichophanes* Cope, 3 sp.; *Amyzon* Cope, 4 sp.; *Rhineastes* Cope, 1 sp.; *Amia* L., 2 sp.

There is a series of calcareous and silico-calcareous beds in Central Utah in Sevier and San Pete counties, which contain the remains of different species of vertebrates from those which have been derived from either the Green River or Amyzon beds. These are *Emys*, sp.; *Crocodilus*, sp.; *Clastes cuneatus* Cope, and a fish provisionally referred to *Priscacara* under the name of *P. testudinaria* Cope. Dr. Hayden first directed my attention to these fossils, and I am indebted to the kindness of the director of the Museum of Salt Lake for the loan of specimens. I afterwards sent a collector to the region, and he obtained a number of fossils.

There is nothing to determine to which of the Eocenes this formation should be referred, but it is tolerably certain that it is to be distinguished from the Amyzon beds. In its petrographic characters it is most like the Green river, as it consists in large part of shales. The laminæ are generally thicker than those of Green and Bear Rivers. The genera Crocodilus and Clastes have not been found heretofore in Green River beds, although they are abundant in the formations deposited before and after that period. Until its proper position can be ascertained, I proposed that the formation be called the Manti beds. (See American Naturalist, April, 1880.)

The regions of the John Day River and Blue Mountains, furnish sections of the formations of Central Oregon. Above the Loup Fork or Upper Miocene, there is a lava out-flow, which has furnished the materials of a later lacustrine formation, which contains many vegetable remains. The material is coarse, and sometimes gravelly, and it is found on the Columbia River, and I think also in the interior basin. Prof. Condon, in his unpublished notes call this the Dalles Group. It is in turn overlaid by the beds of the second great volcanic outflow. Below the Loup Fork follows the Truckee Group, so rich in extinct mammalia, and below this a formation of shales. These are composed of fine material, and vary in color, from a white to a pale brown and reddish-brown. They contain vegetable remains in excellent preservation, and undeterminable fishes. The *Taxodium* nearly resembles that from the shales at Osino, Nevada, and on various grounds I suspect that these beds form a part of the "Amyzon Group" (American Naturalist, June, 1880), with the shales of Osino and of the South Park of Colorado. Below these, is a system of fine grained, some-

times shaly rocks of delicate gray buff and greenish colors, containing calamites, which Prof. Condon calls the *Calamite* beds. Their age is undetermined.

In the existing Geological maps of Oregon, the Coast range is represented as composed of Archæan rocks. This is a serious error. Prof. Newberry has already stated (U. S. Pac. R. R. Surveys, Vol. VI, pt. II, p. 29), that the fossils of the range are of an age not older than the Miocene. The unpublished notes of Prof. Condon, formerly State Geologist, state that the back bone of the Coast range consists of argillaceous shales which contain invertebrate and vertebrate fossils, frequently in concretions. Some of the latter are Physoclystous fishes, with strongly ctenoid scales. To this formation, Dr. Condon gives the name of Astoria shales. Above this is an extensive tertiary deposit, rich in Mollusca, which is usually interrupted by the central elevations of the mountain axis. Prof. Condon refers this to an Upper Miocene age, under the name of the Solen beds. On the flanks of the mountains, this is overlaid by a pliocene formation, containing some of the fossils of the Equus beds of central Oregon. This is both underlaid and overlaid by basalt, and other volcanic products.

Dr. Hayden made a few remarks further illustrating the same subject.

The Report of the Board of Officers and Council was submitted.

Mr. Eli K. Price, Chairman of the Committee on the Michaux Legacy, reported that the copy of the portrait of Mr. Michaux, as ordered by the Society, had been executed, and that he had inspected the same at the rooms of the Society; that the likeness was good and that after certain changes in the background that he would recommend its acceptance by the Society.

Pending nominations Nos. 904 and 909–917, and new nominations Nos. 918 and 919 were read.

And the meeting was adjourned.

Some recent discoveries of stone implements in Africa and Asia. By Henry Phillips, Jr., A. M.

(*Read before the American Philosophical Society, May* 21, 1880.)

Within the last few years the science of Archæology has received many additions through discoveries of stone implements and weapons in the cradle lands of the human race. A lithic age (whether exclusively so or not) seems to have existed in the dominions of the Pharaohs, and in the home of the Vedas, as well as in the rest of the habitable world. To exhibit a short résumé of what has been lately found in Asia and Africa is my object this evening.

In the Bulletin of the Egyptian Institute for 1869, '70, '71, there is much interesting and important matter relating to discoveries in Egypt. At the meeting of the Institute held in December, 1869, M. Lepsius stated that, acting upon information received from M. Lenormant, he had visited the place of an alleged find of stone implements in the neighborhood of Thebes. That he had found them in that place by the thousands; that in fact they were scattered in profusion throughout the entire desert. M. Arcelin, a German dwelling in Upper Egypt, reported that he had found similarly formed implements in deposits later than the tertiary period.

At the seance of April, 1870, Dr. Gaillardot referred to the discoveries reported by M. Arcelin at Cairo, of flint implements, of whose origin, use and authenticity, there could not be the faintest suspicion of doubt. These were found by Mariette Bey in the tombs at Saqqarah, together with ornaments formed of cockle shells. It seems, however, that these relics are not of the oldest stone age, but may be as recent as the historical period of Egypt.

In the tombs at Gourmah, which come down so late as the eleventh dynasty, vast quantities of barbs are found, whose points are sometimes of wood hardened by the action of fire, and sometimes are made of silex or fish bones. It is a very remarkable fact, that in all the remains of Pharaonic antiquity even down to the tombs of the Grecian epoch, no metal arrow-heads have ever been discovered; it is the Grecian sepulchres that are the first to afford bronze points. The Egyptian implements are said to lack the patina which age generally bestows upon genuine implements. This has been urged against them as an argument to prove they were not of the era to which they were supposed to belong. But it is said, that the very oldest of all the primitive silex implements that have ever been found in Europe are likewise entirely devoid of patination, so that no inference can be drawn from this fact.

Zittel found in the Libyan desert vast numbers of flints which bore the appearance of having been operated upon by the hand of man at a period of great remoteness in antiquity. Many of them were found in the desert about twenty miles west of the Oasis of Achel. Stone implements were used by the ancient Egyptians in the process of embalming, and even to this day are still used as razors.

The existence of those at Helwan, on the Nile, nearly opposite the ruins of

Memphis, first became known about 1872, having come to the notice of Dr. Reil, the director of the Sanatarium at that place. He wrote to the Ethnological Society of Berlin, relating the circumstances attending their discovery, and placed a collection of them in the Boulak Museum at Cairo. "The nature of the materials composing the plateau at Helwan varies from layers of fine mud to beds of coarse, angular débris," writes A. J. Jukes Browne, Esq., in a communication to the Cambridge Antiquarian Society, read at the meeting, held November 12, 1877, "and, in the railway cutting, beds of sand and clay are to be seen banked up against the ridge of limestone which rises up out of this valley. "The surface of the plateau is generally composed of loose sand, or stones and sand in place, compacted by saline deposits from the thermal waters which here permeate the soil; and it is upon these surfaces, worn into irregular ridges or hollows, that the flint flakes and tools are generally to be found. They do not occur below the surface except where they have been covered up by subsequent sand drifts. In excavating these sand drifts, implements have been met with at various depths, but none have ever been found in the beds of mud and sand which have been brought down by the streams and are exposed in the cuttings and diggings alongside of the railway. The normal position of the implements is, therefore, upon the surface of the plain; but it is to be noticed that they chiefly occur overlooking the greater depressions where the hardened ground may have existed as a surface for many hundreds, or perhaps thousands, of years; and there are at least five of these spots where the flakes and implements occur in such abundance as to suggest the idea that these were the actual localities where the work was carried on, the very manufactories where the tools of the period were made. The probability that such is the case is increased by the fact that the form of the flakes and the nature of the instruments differ considerably at each of the five places referred to. * * *

"The principal forms that were found, were lance-heads, arrow-heads, saws, long scrapers, thick scrapers, short knives, worked flakes, large flakes, small flakes and one triangular tool. No heavy weapons were found at Helwan, such as hammers, adzes, &c., but parallel cases have occurred where assemblages of small flakes and scrapers have been found at certain spots as if manufactured there, while there is an entire absence of celts, and the larger kind of instruments. Mr. Sketchley states that there is a great resemblance in shape between the Egyptian and the small Suffolk implements. The Helwan lance-heads are good specimens of flint work, the whole surface being worked over, and the sides chipped into serrated edges; they are about three inches long, and the base is squared and thinned off for insertion in the handle. The best arrow-heads are also well made, being of an elongately lanceolate form, the tag end exhibiting two small nicks for the purpose of binding it on to the shaft, in the same way as some of the American arrow-heads were secured.

"But the saws are the most curious and interesting of the Helwan implements; they vary from two to four inches in length, with one side or edge

nicked into wide or narrow teeth, and in some cases cut into a graduating series from large to small teeth. The teeth are often much polished, and sometimes more or less broken as if by dint of hard service, while in some of them both sides are worked into serrations, one edge being more broken than the other, as if it had been used up, and the other side had been chipped out in order to refit the instruments for service.

"The knife-like implements occurred in special abundance, varying in length from one to nearly two inches, but the greater number being about an inch and a quarter long. A few of them are almost semi-lunar in shape, and are similar to those used by the Esquimaux; in the rest, one end is left blunt, and the other brought down to a point, which is generally very sharp.

"Flakes were found at many places in great profusion, together with many of the cores from which they were struck. Almost all the flakes seem to have been utilized, and those that could not be converted into saws or knives were chipped, and evidently used in some way or other."

Mr. Browne has given a very long description of these implements from which I have extracted the foregoing statements. His paper is full of valuable matter, and deserves a careful perusal. He afterwards enters into the discussion of the problem of the antiquity of these flakes and implements, and takes the ground that their occurrence on the surface in no wise prevents them being referred to a remote age, for the reason that in Egypt the surface has probably remained unchanged for a very long period of time. In tombs of the era of the Ptolemies, flint weapons have been discovered, but these cases, Mr. Browne states, are very rare; and those which he saw in the Boulak Museum, "are different in type, and more modern-looking than the Helwan flints. Others which have been found in the neighborhood of Thebes are of a more antique and palæolithic appearance. Sir John Lubbock and others are of the opinion that the implements from Thebes are prehistoric, even as regards a land like Egypt, whose known annals extend backwards over so many thousand years."

The transition from Egypt to Palestine is not an abrupt one, and in the latter country relics of the stone age were discovered, in 1870, at Beth Saour, by Mr. Louis Lartet. Large quantities of stone implements of all kinds were found at this place, of which the bulk were fashioned into the form of knives. One notable exception, however, was a discoid flint resembling the usual European palæolithic type; there were also a needle and an arrow-point formed of bone.

Mr. Lartet is led to believe, from his observations of the locality and of the nature of the find, that there existed formerly at this place, a manufactory, where the fabrication of flint weapons and implements was carried on, such as has been found to exist in many parts of Europe. Since 1870, there have been found at Beth Saour, in addition to the types already spoken of, many knives, scrapers, large graters, bodkins, saws very regularly toothed, chisels which had been polished on stone, and hatchets. With these were mixed deposits of yellow pottery, very roughly made by hand and illy

baked, resembling in the bands, stripes, dots, &c., which constituted their ornamentation, the work of the neolithic period.

In the Troad in Asia Minor, at a town known as Hissarlik, very numerous stone implements have been discovered, of types and shapes analogous to those usually met with in Europe, and are all fabricated of the same rocks that occur in Turkey, Greece and the Archipelago. For example :

Serpentine from Megara, Corinth, Delphos, &c.
Jadeite from Thebes, Althea, Laconia, &c.
Dionite from Sparta, Kleone, Amphyceà, &c.
Amphibolites from Lemnos, Archæà and the Peloponnesus.
Syenite from Mycenæ.

At this latter place Dr. Schliemann reports the discovery of thirty-five arrow-heads of obsidian whose shape was similar to those used in North America.

It is stated that in the museum of the evangelical seminary at Smyrna, there are sixty different implements of stone which have been found in Lydia and Phrygia, of which some were polished, others not. The forms of the hatchets and of the hammers were similar to those previously discovered in Greece. Mr. Pappadopoulos avers that the whole region of Iconium is rich in relics of the stone age, and also that there are abundant vestiges in various lakes of Asia Minor of lacustrian habitations, not unlike those heretofore known in Switzerland.

In Northern Africa stone implements have been found, especially at Khenchela in Algeria. Here M. Jullien discovered quantities of worked flints, generally of large size, although, for the most part, broken. In this instance the finds occurred on the surface of the soil.

Signor Bellucci found in thirteen different portions of the realm of Tunis, no less than 2982 stone implements, being knives, arrow-heads, discs, sling-stones, scrapers, bodkins, beaters, &c. From the surroundings he drew the inference that a workshop for manufacture of stone implements had existed near Tunis.

Messrs. Fraas and Zittel report, severally, similar discoveries in Libya and the Libyan desert. Here the implements were associated with the remains of quaternary animals. Mr. Fraas attributed the worked stones which he found in Libya to the hand of man.

A large collection of stone implements from the Cape of Good Hope, came, a few years since, into the possession of the learned Dr. John Evans, F.R.S., F.S.A., &c., of Hemel Hempstead, England, of which he has been kind enough to write for me the following description : " They appear to be of two different ages, some being apparently palæolithic and closely resembling in form those of the European river gravels and those in quartzite from the latente deposits of Madras ; and others neolithic. Among these latter are numerous flakes of basalt, probably lance-heads, and some well wrought small spear-heads in flint. There are also hammer stones, both perforated and with recesses on one or both sides (possibly these may be more of the nature of mortars), and the usual 'digging stones' for weight-

ing pointed sticks. The palæolithic implements, if such they really be, are scarce. I have one very fine specimen from Proceso Fountain, Victoria, West. It is not of flint but formed of some hard metamorphic rock."

On the 30th of November, 1878, Mr. V. Ball read before the Royal Irish Academy, an essay "on the forms and geographical distribution of stone implements in India," in which country he had resided several years. He goes into the subject at considerable length discussing the various finds in (1) Madras, (2) Hyderabad and the Berars, (3) the Central Provinces and Bandelkhand, (4) Rajputana and Central India, (5) Bombay, (6) Sind and Beluchistan, (7) Bengal and Orissa, (8) Assam and adjoining countries, (9) Burmah, (10) Andaman Islands, (11) Sumatra and (12) Java. As a rule these implements are of the usual types, some, however, in Bandelkhand being evidently symbols of the *Lingam*, some being perforated stones; sometimes they are "well-shaped knives," discoidal objects, flakes and arrow-heads, all palæolithic (only one *polished* celt having been found in the Madras presidency), and a very few polished celts approximating to the unshouldered Burmese forms have been discovered in Assam. In the Burmese implements, however, the cutting surface has a chisel-like edge, while the Assamese tools have the edges ground down on both sides. In the Andaman Islands at the present day, Mr. Ball states, there inhabit a race of people who manufacture flakes from flint pebbles. "The Burmese call these implements *mo-jio*, thunder chain, or thunder-bolt, and believe that they descend with the lightning flash. It is supposed to possess many occult virtues, one of the chief of which is to render its wearer invulnerable, and many an unlucky *mo-jio* has succumbed to the popular test, which is to wrap it in a cloth and fire a bullet at it at short range. If the man misses the cloth the authenticity and power of the charm is at once established: if the stone is fractured it is held not to be a real *mo-jio*. Other less severe tests are also applied. Fowls, it is supposed, will not venture near rice on which a real *mo-jio* is lying; fire will not consume a house that contains one; a plantain tree cut down with one will not sprout again; and last, but not the least in esteem, the owner of a real *mo-jio* can cut a rainbow in half with it."

In Java a considerable series of chipped implements and polished celts has been found, "which have been reported on by a commission appointed for the purpose by the French Academy of Science."

Mr. Ball (p. 399) calls particular attention to a ring stone, too heavy for a spindle whorl or net sinker, and which he believes was really a weapon of offence to be grasped in the hand and used, as he expressed it, as a sort of "knuckle duster," in an encounter between men and wild animals. The chief point of interest about it is its very close resemblance to forms which have not uncommonly been met with in Europe, and likewise in Pennsylvania, Virginia and other parts of North America.

Accompanying Mr. Ball's paper is a map of the geographical distribution of stone implements in India. "The chipped quartzites occur throughout a vast area north and south from Sangor to Madras, east and west from Raniganj in Bengal, to Neemuch in Rajputana. Even

in far distant Java implements of a somewhat similar character have been met with; a fact of considerable interest pointing to a prehistoric connection. Flakes and cores are limited in their distribution to the area which extends north and south from Kerowlie in Rajputana, to Peyton on the Godaveri, in Bombay, and east and west from Singhbhum, in western Bengal, to Sukkur on the Indus, in Sind, and still further even to Gwadar, in Beluchistan. The polished celts extend from Upper Assam to Singhbhum, in Bengal, and from the Irawadi Valley, in Burmah, to Jabalpur, in the Central Provinces."

The map is colored to show these distributions respectively for each class in the order above referred to, light pink, light purple, and light blue. Mr. Ball offers two theories to account for this distribution of flint implements; one, that from a central interior point spread forth successive waves of emigration at different stages of civilization; the other, to which he inclines, was that the central area was a point of convergence rather than of divergence, basing his opinion on the fact that the manufactures become more abundant, and exhibit greater skill in proportion as we recede from this central area. A fact tending, in his judgment, to corroborate the notion that India was once an island, which gradually arose from the ocean at a period subsequent to its first being inhabited; that as the central parts of the country became accessible to wanderers from the surrounding quarters, with a knowledge of their respective arts, were thrown more in contact with each other, becoming the ancestors of some of the widely distinct races now living in India." Mr. Ball adds to his paper a list (covering twelve pages 8vo), of the localities in India where ancient stone implements have been discovered, and I would call your attention to the whole article from which these extracts (referring to India) have been taken as being carefully written and of great interest and importance. (Proceedings of the Royal Irish Academy, Dublin, Vol. 1, Ser. ii, No. 13, April, 1879.)

In the opinion of some writers of prominence and ability, the very existence of a stone age, *per se*, has been doubted, and the suggestion thrown out, which is plausible enough, that lithic implements, &c., were used in connection with others of metal which have not survived to modern times. It is not my wish to enter into any controversy respecting this much vexed question. My only object in the present instance has been to gather into one paper valuable facts, at present dispersed and scattered.

[Note.—At the Congress of Archæologists, in 1872, the Marquis de Vibray, exhibited a collection of stone implements, &c., found in Japan, amounting in all to sixty-seven. Of the hatchets many were perforated, and the types all bore resemblance to similar ones found elsewhere. The chief material of which they were formed was *jade*, but other stones were also used, including *obsidian*. The age of these objects could not be satisfactorily determined, nor what the relative civilization of Japan was in what seemed to be a polished stone age.

Within the past year (1879) dolmens have been opened in Japan in which stone arrows, &c., have been found. It is stated that the shell mounds at Amori contain bones of monkeys, deer, boars, wolves, and dogs, with not a few remains that plainly point to the former prevalence of cannibalism. In Cochin-China, the French aggressions have led to the discovery of stone implements, undoubtedly fashioned by the hand of man, among pottery, shells, and human and animal remains.]

Stated Meeting, June 18, 1880.

Present, 9 members.

President, Mr. FRALEY, in the Chair.

Mr. Wm. B. Rogers, Jr., a newly-elected member was introduced and took his seat.

Letters accepting membership were received from Joseph A. Murray, dated Carlisle, Pa., May 31, 1880; and from Ogden N. Rood, New York, May 10.

Letters of acknowledgment were received from the Royal Zoölogical Society, Amsterdam, dated June 2, 1880 (104); and the Royal Geological Society of Ireland (104).

Letters of envoy were received from H. Scheffler, dated Braunschweig, April 30, 1880; the Board of Commissioners of the Second Geological Survey of Pennsylvania, May 20; Mr. Frederick Fraley, Philadelphia, June 16; and John Hay, Assistant Secretary of the Department of State, Washington, May 22.

A letter was received from the Librarian of the Cincinnati Public Library, dated May 24, 1880, requesting to be allowed to buy certain volumes of the Transactions of the Society. The matter was referred to the Librarian with power to act.

A circular letter was received from the Smithsonian Institution, dated June 1, 1880, asking certain questions concerning the condition of the Society and its Library.

Donations for the Library were received from the Bureau of Mining, Melbourne; the Governor General of India; Academies at St. Petersburg, Berlin, and Rome; Observatory at Prague; Bureau of Statistics, Stockholm; Editors of Flora Batava, Leyden; Dr. Hermann Scheffler, and the Editor of the Zoologischer Anzeiger, Leipsig; M. A. Delesse, and the Editors of the Revue Politique, and Annales des Mines, Paris; Commercial Geographical Society, Bordeaux; Editor of the Revista Euskara, Pamplona; R. Astronomical Society, Victoria Institute, and Editors of Nature, London; Essex Institute, Salem; American Journal, New Haven; Brook-

lyn Entomological Society; American Chemical Society, and Editors of the American Entomologist, New York; Rensselaer Polytechnic Institute, Troy; Editor of the North American Entomologist, Buffalo; Zoölogical Society, Franklin Institute, Editors of the Medical News, and the American Journal of Pharmacy, Mr. Henry Phillips, Jr., Dr. F. V. Hayden, Mr. Chapman Biddle, and Mr. Benjamin H. Smith, Philadelphia; Mr. Peter Sheaffer, Pottsville; Board of Commissioners of the Second Geological Survey, Pennsylvania; Peabody Institute, Baltimore; Wabash College, Indiana; Col. Chas. E. Jones, Augusta, Georgia; Geographical and Statistical Society, and Editor of the Revista Cientifica Mexico; and Mrs. Ellen L. Schott.

Mr. Blodget made the following remarks upon certain features of Industrial Migrations as shown in the manufactures of Philadelphia.

The development of many of the industries of Philadelphia presents characteristics strikingly resembling those of nations conspicuous in history for industrial prosperity. History as usually written affords but an imperfect view of the real causes of national growth, and we are led to infer that the employment of the people is altogether secondary and subordinate. One of the best of the more authentic and better works which should take the place of histories is a treatise by the Marquis De Uztariz, on the industrial economy of Spain, originally printed in 1724, and reprinted in England in 1751, by John Kippax, under the patronage of the Prince of Wales. It gives a vivid picture of the great industries in wool and silk which made Spain rich and prosperous before the gold of the New World was known. Seville, Granada, Cordova and Toledo became magnificent cities through these industries in wool and silk, and sent Spanish cloths and embroideries to every country of Europe. Seville alone had 16,000 looms, employing 48,000 persons, and maintaining directly 12,000 families, or 60,000 persons. But this statesman of that early period found that great misfortunes followed the neglect of manufactures, and that a false policy of taxation had transferred many of them to France and the Low Countries. He wrote earnestly in resistance of that policy, and struggled to restore the ancient splendor of those great cities. The Spanish ruling class was infatuated with the gold and silver of the American colonies, however, and the first great industrial migration carried what remained of them into the Low Countries, from which they were subsequently drawn partly into France, by the skill of Minister Colbert, and still later into England.*

*The origin of these industries of Spain is so forcibly told by Marquis De Uztariz that I quote from his chapter citing the laws of King Ferdinand, Ferd-

At the first examination I had the opportunity to make of the textile industries of Philadelphia, I was struck by the evidence afforded that they represented a migration and transfer which would soon attain much greater proportions, and which even then deserved public attention as an important interest. I published a list of mills in 1857, and again in 1858, writing frequently in regard to it, and reprinting the Census of 1860, of which I had the supervision so far as related to manufactures. In that year I had the opportunity to show to Mr. W. S. Lindsay, member of Parliament from a north of England district, the work of thousands, recently emigrated from Nottingham, Leeds and other manufacturing districts, claiming that a transfer of those industries was in progress which would have a great influence on the future of the United States. Again in 1870 the evidences became still more decisive and the rate of progress much more rapid, but it was reserved to the period from 1876 to 1880 to complete what must be regarded as the most striking and massive of the great historic movements which have, since the 15th century, carried from one nation to another the crown of ascendancy in textile industries. I am well aware that it will not be admitted in many quarters that this movement has gone so far as I claim. This point is not material, however, if the facts of rapid progress in that direction are conceded. No one can deny that the most important successes have attended the effort to establish the textile industries here, and that they represent an extent of employment of productive power in looms and machinery exceeding the most prosperous days of Seville or of Manchester.

The point of interest in the philosophic sense is this apparent relation of national development to these greater industries. It is singular that they have migrated as national supremacy has changed its place, or more probably that an enforced migration has been the chief agency in building up one country at the expense of another. Spanish prosperity may very naturally have been supposed to be inseparable from the Spanish race during the period in which Ferdinand and Isabella "published one hundred and

inand and Isabella, and the Emperor Charles V, as follows: "The ancient his-
"torians, more inclined to speak of battles, sieges, revolutions and other events
"that make a noise in the world, than to transmit the publick measures in fa-
"vor of commerce, take little notice of the provisions made for its encourage-
"ment by our great monarchs, who most distinguished themselves by their
"wisdom in the arts of peace and war. King Ferdinand, the Pious was of this
"class, and in his reign there is mention of one circumstance on this head,
"that after he had rescued the city of Seville from the yoke of the Mohamme-
"dans in 1248, he settled there many artificers who are the basis of a profitable
"commerce, which is alone attainable by good manufactories." Next, their Majesties, Ferdinand and Isabella, by statutes of 1478 to 1494, made various regulations in favor of manufacturers of silks, brocades and cloths, and the said Ferdinand and Queen Juana, his daughter, in 1511, "published 119 laws respect-
"ing the fabrication, dying and sale of cloths and stuffs, every one of which
"tended to make improvements in these manufactures." Also, the Emperor Charles V., by statutes of 1528, 1549, 1552 and others, added a hundred further laws regulating these industries, but during this century the imposition of heavy internal taxes aided the transfer of many textile industries to Flanders, and in part to France.—*See Kippax's translation*, 1751, *Vol. I, p.* 196, *&c.*

nineteen laws respecting the fabrication, dying, and sale of cloths and stuffs, every one of which tended to make improvements in each of the several manufactures" ; but two centuries later this industry had gone from Spain and from the Spanish race to countries in the north of Europe. From Europe to this country the transition is perfectly natural and easy, coming with the immigration which all the circumstances unite in inviting. It is not in opposition to race prejudices, but entirely in accord with them, that the crowded populations of French or English cities should bring with them the industries which found their best market here, and establish silk weaving, tapestries, damasks, and all forms of ornamented tissues in silk and wool, as well as the plainer fabrics which are more promptly introduced. It is certain that they are being so introduced, and with a degree of rapidity much greater than is usually supposed.

The elements of permanence belonging to this movement are, however, better shown in the transfer of English industries in wool and cotton, than in the silk and worsted of France and Germany. The English movement has been in progress for twenty-five or thirty years, with a preliminary or partial movement from the north of Ireland and extreme north of England fifty years ago. Hand loom weaving in linseys and colored cottons was the distinctive form here, while the cloth fulling and woolen cloth weaving from the west of England was common to the whole country. Closely following these was the carpet weaving, which originated in France, but was given a form better adapted to general use in the English ingrains, and one which transplanted here has been extended with great rapidity and success. Yet the weavers are English, and establishments whether of the smallest or of enormous magnitude represent English migrations chiefly, and bring with them all that English skill has attained, as well as add the most recent American peculiarities. The impression they make is very striking, that it is not any present commercial or business advantage that has brought them, and that the 6000 men of English birth which the carpet industry alone employs in Philadelphia, are greater than all the temporary circumstances that can surround this carpet industry as a business. Their presence creates many of these circumstances, and naturalizes the change.

In the hosiery and knit goods industry there is a large preponderance of English identity, as it may be said, of identity in machinery, in workmen and in proprietorship, but there is also a considerable share of German and French elements of each of these classes. The variety of fabrics and articles made in this manner is much greater than is usually supposed, scarcely an article of finished clothing being excepted. Shawls, scarfs, caps and head dresses, coats or jackets, sleeves, gloves, &c., with all forms of hosiery proper, enter into consumption in this country to the extent probably of forty millions of dollars in value yearly. Under the effect of recent developments, four-fifths of the supply required is now produced here, and with changes in design and adaptation constantly effected, the industry itself is much extended and enlarged.

These primary and necessary industries, as they may be characterized, are here as highly developed in ornamentation and artistic effect as many of the more costly textile fabrics. Once established on a basis of skilled artizans resident here the changes which are required for assimilation with the country are effected easily and without disturbing that basis, or weakening its identity. The German workman is not less a German or the English knitter not less a representative of English skill because of the new adaptations which he acquires here, or is directed to employ by a proprietor who uses steam power where hand power only was previously employed.

This age is as luxurious in some of its tastes and demands as any that has preceded it, but in others it is much more moderate. The costly royal cloths of Spain, rich of themselves and loaded with gold or silver embroidery, are no longer demanded by any market; and it is only in fabrics exclusively of silk that such obvious luxury finds an acceptable outlet. But what is wanting on the more costly is more than made up on the average quality of fabrics in universal use.

The relation of these industries to the prosperity of the cities where they exist, and to that of the nation or country in which they form a prominent feature of general business, is not less marked now than at any former period. And the adaptations of steam power, which now increase production enormously without impairing its quality, must invariably accumulate wealth more rapidly than was possible before steam was known. The 16,000 looms of Seville constituted a remarkable productive force for the age in which they flourished, and they may well be named with pride by the Spanish minister; but there are 30,000 looms driven by steam power in Philadelphia, producing a vastly greater aggregate of such fabrics as this age demands; and though inferior in costliness, it is probable that they are as productive in material wealth to the city as were the looms of that once splendid city of Spain.

If this is in fact the natural line of movement from one country to another of these greater industries, the matter is worthy of consideration on higher grounds than those which are merely commercial or industrial in the business sense. The evidence is too strong to admit of doubt that the industrial migrations, taking with them the foundation industries in wool, silk and cotton, have made this city of Philadelphia their chief point of destination; not exclusively, however, but with a liberal distribution in northern cities. They do not find so much to favor them in the factory towns of New England, to which only the workmen in like factories in England or on the continent find themselves adapted. These factories represent a different class, distinctly separated from the aggregations of skilled workmen in Lyons, Paris, Philadelphia and like large cities. They are in some respects higher and more advanced developments; but they rest on a more narrow basis. A factory or corporation may exist for twenty years in one locality without fixing there an associated business which would survive the stoppage of the one mill. But here it is the workmen and their looms that constitute the fixture. The mill and the steam power are a valuable

adjunct, but the work can go on without them. Nothing but the *Alcavala* of ruinous taxation, or the substitution of a tax on exports for the proper tax on imports, as was done under the corrupt rule of the monarchs who ruined Spain, can destroy indigenous or thoroughly nationalized industries such as these.

The foundation industries in wool, cotton and silk have come here to stay; they have come from England first, and next from Germany and from France; and they already furnish an addition of many thousands of trained adults, men and women, to the body of the population of the greater cities of the United States.

Mr. Phillips called to the attention of the Society the new Dictionary of the English Language which was now approaching its completion.

The first germ of the project grew out of a paper read before the Philological Society in 1857, by Archbishop Trench, on "Some deficiencies in our English Dictionaries." The Society, subsequently, in 1859, issued a "Proposal for the publication of a New English Dictionary," in which the general scope and method of the intended work were set forth. The heavy financial outlay requisite and other obstructing causes retarded the work till about three years ago, when Dr. J. A. H. Murray, President of the Philological Society and Master of the great Mill Hill School, in London, took up the management and infused a new vigor into the undertaking. The plan is to furnish a history of each word in the English language, with a quotation from some author in every century since its first appearance, thus showing the date of its entrance, and the progressive changes, if any, which have occurred in its form and meaning. According to the materials already in hand, giving a sentence for every citation, the Dictionary would fill seven quarto volumes of 2000 pages each, but the intention is to reduce the quotations, when it can be done, to a smaller compass, thus keeping it within the trivial limit of "7000 quarto pages of the size of Littré's French Dictionary, making a work one and a half times the size of that, or more than four times the size of Webster, say in four thick volumes quarto." The book will be published at the Clarendon Press, Oxford, and the intention is that it shall be completed within ten years. The first part of 400 pages containing the letter A is to be ready in 1882, the residue to follow at regular intervals until the whole is finished. The supervision of the reading for the Dictionary done in America, has been confided to our fellow-member, Professor March, of Easton, Pa., who has awakened and stimulated the interest in this country, so that from Maine to Oregon daily contributions of quotations are pouring in to the learned editor.

When finished, the Dictionary will be one of the great books of the world, a stupendous monument for all time to the industry, zeal and learning of the scholars of the nineteenth century.

A letter was read from Mr. Eli K. Price suggesting that

photographs should be taken from the portrait of Mr. Michaux, for distribution among prominent botanists and botanical institutions. On motion an appropriation of $25.00 was made for the purpose.

The Committee to attend the Centennial Celebration of the American Academy of Arts and Sciences at Boston, reported and was discharged.

And the meeting was adjourned.

Stated Meeting, July 16, 1880.

Present, 4 members.

Vice-President, Dr. LeConte, in the Chair.

A photograph of Henry Armitt Brown, a late member of the Society, was received for the album.

Letters of acknowledgment were received from the Statistical Society of London, dated June 24, 1880 (103, 104); and the Royal Danish Academy, Copenhagen, June 7, 1880 (103, 104).

Letters of envoy were received from the Trigonometrical Branch of the Survey of India, dated Dehra Dun, May 5, 1880; the Meteorological Office, London, June, 1880; and the Department of the Interior, Washington, D. C., June 29, 1880.

A letter was received from Mr. Murray, Acting Secretary of the American Philological Association, tendering the thanks of the Association for the use of the rooms of the Philosophical Society, and for the courteous attentions received by the Association.

A postal card was received from the American Chemical Society, stating that they had not received No 104, of our Proceedings.

Donations for the Library were received from the Acad-

emies at Buda Pest, Copenhagen, Berlin, Rome, Brusselles, and Philadelphia; Editor of the Zoologischer Anzeiger, Leipsig; Société Vaudoise, Lausanne; Cav. Damiano Muoni, Milan; Editor of the Revue Politique, Paris; Society of Commercial Geography, Bordeaux; Editor of the Revista Euskara, Pamplona; Royal Astronomical Society, Dr. C. William Siemens, and the Editors of the Chemists' Journal, and Nature, London; American Journal, and Yale College, New Haven; Metropolitan Museum, N. Y.; Pennsylvania Historical Society, Franklin Institute, Journal of Pharmacy, and Medical News, and Mr. Lorin Blodget, Philadelphia; Mr. P. W. Shaefer, Pottsville; U. S. National Museum, Smithsonian Institution, and Department of the Interior, Washington, D. C.; American Philological Association; Dr. Robert Peter, Frankfort, Ky.; Editor of the Revista Cientifica Mexicana, and the Ministerio de Fomento, Mexico.

Prof. E. D. Cope presented a paper "On the genera of the Creodonta."

On account of the small attendance the election of members was postponed until the next stated meeting.

Pending nominations Nos. 904, 909 to 915, 917 to 919, and new nomination No. 920, were read.

And the meeting was adjourned.

On the Genera of the Creodonta. By E. D. Cope.

(*Read before the American Philosophical Society, July* 16, 1880.)

For the characters of this group of the unguiculate mammalia, the reader is referred to the fourth volume of the final Report of the U. S. Geol. Survey W. of the 100th Mer., under Capt. Wheeler Pt. ii, p. 72.

History. MM. Laurillard, Pomel and others have referred the European *Creodonta* to the *Marsupialia*, on account of the great similarity of the dentition. MM. De Blainville and Gervais have, on the other hand, regarded them as placental, a view which I have assigned reasons* for believing to be the correct one. M. Filhol has recently shown that the replacement of the dentition in *Hyænodon*, which has some affinities with

* Proceedings Academy, Phila., 1875. Paleontological Bulletin No. 20, Dec., 1875.

the *Creodonta*, is quite as in true placental *Carnivora*. Professor Gaudry has expressed the opinion that the *Creodonta* are the descendants of the *Marsupialia*.* I incline to maintain another view.

If we suppose that the *Creodonta* are the descendants of the *Marsupialia*, we must suppose that the *Insectivora*, to which they are related, are also the descendants of the *Marsupialia*, and this is on various grounds not very probable. The lower forms of unguiculate mammalia with small cerebral hemispheres are very much alike in important characters, and to these I have given the name of *Bunotheria*. I suspect that this group is as old as the *Marsupialia*, and may even have given origin to it. That it developed cotemporaneously with it in various parts of the world is evident.

Restoration. The Wasatch beds of New Mexico have yielded remains of more than a dozen species, which ranged from the size of a weasel to that of a jaguar. The Bridger beds of Wyoming probably contain as many species, which range from small size to the dimensions of a bear.

In general appearance, the *Creodonta* differed from the *Carnivora*, in many of the species at least, in the small relative size of the limbs as compared with that of the head, and in some instances as compared with the size of the hind feet. The feet are probably plantigrade, and the posterior ones capable of some degree of horizontal rotation. The probable large size of the rectus femoris muscle indicates unusual power of extension of the hind limb. They were furnished with a long and large tail. Probably some of the species resembled in proportions the *Mystomys* and *Solenodon*, now existing in Africa and the West Indies, but they mostly attained a much larger size. The habits of many of them were probably aquatic.

Classification. To the *Creodonta* I have referred,† on the information which we possess, the genus *Arctocyon* of Blainville. Professor Gervais has discovered that it possessed the very small cerebral hemispheres characteristic of the *Creodonta*. The olfactory lobes are large, and project far beyond the hemispheres, while not only the cerebellum, but probably the corpora quadrigemina, were exposed behind. The tarsal articulation and the posterior part of the mandibular bones are unknown, hence this reference is not certain. Professor Gervais‡ regards it, after Laurillard,§ as a marsupial, and establishes an especial family of the order for its reception. It is, however, more probable that its affinities are with the contemporary genera of flesh-eaters, *Palæonyctis* Blv., and *Pterodon* Blv., genera which have near allies among the American forms. *Palæonyctis* was the contemporary of the Coryphodons in the Suessonian period of Western Europe, and presents a strong resemblance to *Amblyctonus* in its mandible, the only part of the skeleton known. The posterior part of the ramus is not inflected according to Gervais, and he therefore does not refer it to the *Marsupialia*.‖ The nearest European representative of *Oxyæna* is *Ptero-*

* Enchainements du Monde Animal, 1878, p. 24.
† Report Capt. G. M. Wheeler, Expl. Surv. W. 100 Mer. 1877, iv, pl. ii, p. 88.
‡ Nouv. archives du museum, 1870, p. 150.
§ Dict. univ. d'hist. naturelle, ix, p. 400.
‖ Nouv. archives du museum, 1870, 151.

don, in which the form of the mandible also forbids a reference to the *Marsupialia*, as Gervais has remarked. Both genera are doubtless members of the sub-order of *Creodonta*. The genus *Hyænodon*, on the other hand, is not referable to the same group, for I find in a specimen of the *H. requieni* from Desbruges, preserved in the Museum of the Jardin des Plantes, that the scaphoid and lunar bones are coössified. Moreover the figure given by Professor Gervais* representing the brain of the originally-described type, *H. leptorhynchus* of the Miocene period, displays characters of the true *Carnivora*. The anterior part of the cranial cavity of the specimen molded is broken away.

It is possible that the genus *Diacodon* Cope belongs here also; its species resemble slightly the *Marsupialia* in the inferior dentition, and are of small size.

The genus *Mesonyx*,† which I discovered in the Bridger beds of Wyoming, has the trochlear face of its astragalus completely grooved above as in the true *Carnivora*, and its distal end presents two distinct facets, one for the cuboid, and the other for the navicular bones. It represents on this account a peculiar family, the *Mesonychidæ*.

There are various degrees of development of the sectorial structure of the molars in this sub-order. In some of them, as *Didymictis*, only one of the inferior molars presents this structure; in others two, and in others three. In one type, the last superior molar is longitudinal; in others, it is transverse. In *Arctocyon* the superior true molars are tubercular.

I have heretofore‡ defined three families, the *Amblyctonidæ*, the *Oxyænidæ*, and the *Arctocyonidæ*. I now add the *Miacidæ* and *Mesonychidæ*. The definitions are as follows:

I. Ankle joint plane transversely.

True molars above and below tubercular; last superior not transverse	*Arctocyonidæ*.
Superior true molars tubercular; first inferior "tubercular-sectorial"	*Miacidæ*.
Last superior molar trenchant, transverse; inferior true molars tubercular-sectorial	*Oxyænidæ*.
Last superior molar longitudinal; inferior true molars without developed sectorial blade	*Amblyctonidæ*.

II. Ankle joint tongued and grooved, or trochlear.

Inferior molars each with one conic tubercle and a heel; no developed sectorial blade	*Mesonychidæ*.

I now give the characters of the genera. All these are derived from examination of typical specimens. The opportunity of doing this I owe to the kindness of Messrs. Leidy, Gervais, Gaudry, Filhol and Lemoine.

* Loc. cit., pl. vi, fig. 5.

† Ann. Rept. U. S. Geol. Surv. Terrs., 1872, p. 550.

‡ Report Capt. G. M. Wheeler's Expl. Surv. W. 100 Mer., 1877, iv, pl. ii, p. 89.

ARCTOCYONIDÆ.

Premolars $\frac{4}{4}$; the first inferior one-rooted; the last inferior well developed..... *Arctocyon* Blv.
Premolars below, 4, the first two-rooted, the last true molar much reduced..... *Hyodectes** Cope.
Premolars below, 3, first two-rooted; true molars normal..... *Heteroborus*† Cope.

MIACIDÆ.

Inferior tubercular molars two, premolars four..... *Miacis* Cope.
Inferior tubercular molars one, premolars four..... *Didymictis* Cope.

OXYÆNIDÆ.

I. Inferior molars without internal tubercles.

Molars, $\frac{4}{3}$ $\frac{3}{3}$; three sectorials in the lower jaw..... *Pterodon* Blv.

II. Inferior molars with internal cusps.

Molars, $\frac{4}{4}$ $\frac{3}{2}$; two last inferior molars tubercular-sectorial..... *Oxyæna* Cope.
Premolars $\frac{4}{4}$; three last inferior molars tubercular-sectorial; the fourth superior with a conic cusp and heel externally..... *Stypolophus* Cope.
Premolars $\frac{4}{4}$; three last inferior molars tubercular-sectorial; fourth superior premolar with a simple blade externally..... *Proviverra* Rütim.

AMBLYCTONIDÆ.

Fourth inferior premolar with a broad heel supporting tubercles..... *Amblyctonus* Cope.
Dental formula below, 3, 1, 3, 3. Fourth inferior premolar with a cutting edge on the heel ..... *Palæonyctis* Blv.

MESONYCHIIDÆ.

Inferior molars seven..... *Mesonyx* Cope.
Inferior molars five..... .... *Patriofelis* Leidy.

Of the preceding genera it may be remarked, that the structure of the feet of *Pterodon* being unknown, it may be found hereafter to be necessary to remove it from the *Oxyænidæ*, although I do not anticipate that such a course will be necessary. *Palæonyctis* is only known by the mandibular dentition, which is very near to that of *Amblyctonus*. So also it is not certain, but only probable, that *Patriofelis* belongs to the *Mesony-*

* Type *Arctocyon gervaisii* Lemoine, Oss. Foss. des Envir. de Reims, 1878, p. 8.
† Type *Arctocyon duelii* Lemoine, l. c., p. 9.

chidæ of the same horizon and locality. The horizontal and geographical distribution of the species of these thirteen genera is as follows:

	Lower Eocene.		Upper Eocene.	
	N. A.	Eur.	N. A.	Eur.
Arctocyon primævus Blv		*		
Hyodectes gervaisi Lem.		*		
Heteroborus duelii Lem.		*		
Miacis parvivorus Cope			*	
" edax Leidy			*	
" vorax Leidy			*	
Didymictis protenus Cope	*			
Pterodon dasyuroides Blv		*		
" biincisivus Filh				*
Oxyæna morsitans Cope	*			
" lupina Cope	*			
" forcipata Cope	*			
Stypolophus viverrinus Cope	*			
" secundarius Cope	*			
" multicuspis Cope	*			
" strenuus Cope	*			
" minor Filh				*
" caylusi Filh				*
" pungens Cope			*	
" brevicalcaratus Cope			*	
" aculeatus Cope			*	
" hians Cope	*			
Proviverra typica Rütim		*		
Amblyctonus sinosus Cope	*			
" sp. no. 2†		*		
Palæonyctis gigantea Blv		*		
Mesonyx obtusidens Cope			*	
" lanius Cope			*	
Patriofelis ulta Leidy			*	

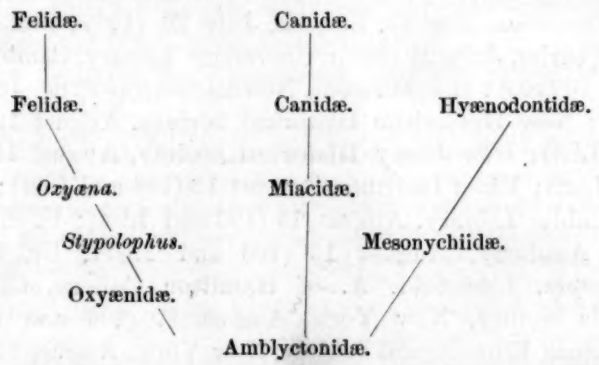
Phylogeny. It is among the genera above enumerated that we are to look for the ancestors of the existing *Carnivora*, excepting perhaps the seals, and even these were probably cotemporaries. In those genera without developed internal tubercles of the molars, we may look for the ancestors of the *Hyænodontidæ*, a family which early attained specialization at the expense of strength of structure, and did not survive the lower Miocene period. Such genera may be found in the *Mesonychidæ* as the later, and the *Amblyctonidæ* as the earlier types.

In distinguishing between the ancestors of the *Felidæ* and *Canidæ*, we naturally seek to recognize in each, an anticipation of the leading characters in the dentition which distinguish those families to-day. This consists, in the *Felidæ*, in the successive abbreviation of the true molar series from behind, so that ultimately two molars are lost, and the remaining or anterior one becomes transverse. On the other hand in the *Canidæ*, firstly,

† Represented by a mandible with teeth, from Meudon, associated with the specimens of *Palæonyctis* in the Mus. Jardin des Plantes.

the full number of true molars is retained in some genera, as *Amphicyon*, and only one lost in *Canis*. Secondly, the tubercular character of the posterior molars in both jaws in the *Canidæ* is distinguished from their sectorial character in *Felidæ*. Estimated by these tests the *Miacidæ* are clearly the forerunners of the *Canidæ*, and the *Oxyænidæ* of the *Felidæ*. In *Miacis* we have in fact a near approach to the dentition of *Canis*, in the lower jaw; while in the same part of *Didymictis* posterior abbreviation has commenced, reminding one of *Viverra*. In the *Oxyænidæ*, one degree of posterior abbreviation is seen in *Stypolophus*, where the last superior molar is narrowed and turned at right angles to the others. In *Oxyæna*, the process had advanced a step, for there are but two superior true molars, and the last of these is driven in, transversely. The first true molar is functionally sectorial in this genus, while the last premolar is the true sectorial of the superior series in existing *Carnivora*. In the inferior series there are only two true molars in *Oxyæna*, both primitive, or "tubercular-sectorial" in character. In existing *Felidæ* the second is lost, while the first undergoes great changes in becoming a specialized sectorial. The forms of the *Felidæ*, which are nearest, are the *Cryptoprocta*, and the *Proælurus* of Filhol, but they only follow after a wide interval. I have elsewhere discussed the successive steps in the evolution of the sectorial itself.* I have also pointed out† the successive shortening of the anterior part of the dental series in the *Felidæ* and other groups of existing *Carnivora*, which came later in time.

The following table will give an idea of these affinities, and the phylogeny to be derived from them:



Synonymy. Prof. Gaudry has united *Stypolophus* (*Cynohyænodon* Filhol) with *Proviverra*. After an examination of casts of Rütimeyer's types preserved in the Museum of the Jardin des Plantes, I retain them as distinct for the reasons given above. Mr. Bose in an interesting paper on this subject published in the London Geological Magazine for May and

* Proceedings Acad. Phila., 1875, p. 21.
† Felidæ and Canidæ, l. c., 1879, p. 169-170.

June, 1880, unites *Didymictis* with *Palæonyctis*.* Having examined the types of both genera, my conclusion as expressed in the preceding pages is very different. On the other hand, I have good reason for believing the species to which the name *Synoplotherium* was given, *S. lanius*, is really a second species of *Mesonyx*, of larger size than the *M. obtusidens*, and otherwise different. It is likely that some of the species of the Bridger formation, to which Marsh has applied generic names, belong to the *Creodonta*, and may belong to some of the genera described by myself. The fact that no generic definition accompanied the publication of those names, renders their use impracticable.

Stated Meeting, August 20, 1880.

Present, 4 members.

President, Mr. FREDERICK FRALEY, in the Chair.

Mr. Joseph C. Fraley, a newly elected member, was introduced, and took his seat.

Letters of acknowledgment were received from the Royal Society, June 3 (100, 101, 102, 103); the Royal Society, New South Wales, June 14 (101, 102, 103); Royal Institution, July 12 (105); the Victoria Institute, July 10 (105); the Statistical Society, London, July 20 (105); Society of Antiquaries, July 21 (105); University Library, Cambridge, July 19 (105); the Museum, Newcastle-upon-Tyne, July 19 (105); New Hampshire Historical Society, August 12 (106 and List); New Jersey Historical Society, August 11 (106 and List); Essex Institute, August 12 (106 and List); Boston Public Library, August 14 (106 and List); U. S. Military Academy, August 13 (106 and List); Dr. C. H. F. Peters, Litchfield, A. of Hamilton College, Clinton, Oneida county, New York, August 17 (106 and List); American Ethnological Society, New York, August 12 (106 and List); Connecticut Historical Society, Hartford, August 18 (106 and List); American Antiquarian Society, Worcester, August 13 (106 and List); and from Dr. E. Jarvis, Prof. W. P. Blake, Dr. T. M. Drown, and Mr. W. B. Taylor (106 and List).

*I have just seen this paper, having already written what precedes this paragraph.

Letters of envoy were received from the Adelaide Observatory, June 3, 1880, and the Government of Victoria, Australia, Agent General for Victoria, June 8; Victoria Chambers (Westminster, S. W.), April 28, 1880.

A letter was received through Mr. Phillips from Mr. B. B. Diney, dated 3822 Market street, Philadelphia, July 16, accompanying a piece of the cog-wheel of the old Independence Hall Clock.

Donations for the Library were received from the Prussian Academy; Zoologische Anzeiger; Geographical Society of Paris; Annales des Mines; Revue Politique; Commercial Geological Society of Bordeaux; Belgian Academy; Nature; Franklin Society, Providence, R. I.; Cambridge Observatory; American Chemical Society, New York Academy of Sciences; American Academy of Sciences, Boston; Franklin Institute; Journal of Pharmacy; Medical News; American Journal of Science; U. S. Coast Survey; U. S. Geographical Surveys; Missouri Historical Society; American Antiquarian, Chicago; Bol. Min. de Fomento, Revista Scientifica, Mexico; Revista Euskara, Pamplona; Camoëns Celebration, Lisbon; Asiatic Society of Japan; Government of Victoria and New Holland Institute.

The death of Dr. Paul Broca, at Paris, July 10, 1880, was announced.

The death of M. Viollet le Duc, not previously noted, was also reported.

Communications were received from Prof. John J. Stevenson. 1. "Notes respecting a re-eroded channel-way;" and 2. "Notes on some features of the geology of Wise, Lee and Scott counties in Virginia;" each illustrated by three cuts.

Mr. Fraley reported the receipt of the last quarterly interest on the Michaux legacy, $132.12, due July 1, 1880.

The Publication Committee reported that they had seen and approved the drawings of fourteen plates for Prof. S. S. Haldeman's memoir on the Chickis cave relics.

And the meeting was adjourned.

Notes respecting a Re-eroded Channel-way. By John J. Stevenson, Professor of Geology in the University of the City of New York. (With three wood cuts.)

(*Read before the American Philosophical Society, Aug.* 20, 1880.)

The north branch of the Canadian river is formed near west longitude 104° 30′ at about 25 miles south from the northern boundary of New Mexico by two small streams, which rise in the Raton hills and drain much of the Trinidad Coal Field. Within 25 miles, the river enters a cañon, which deepens rapidly until, at 50 miles from its head, its nearly vertical walls are almost 1100 feet high, while the width of the gorge at the bottom varies from 150 to 800 feet. Thus far no important tributary enters the river in the cañon, but the petty side-cañons show that at some time or other much water must have flowed in from the Canadian plains. At probably 50 miles from the head of the cañon the Canadian river is increased by the Mora river, which rises on the east slope of the Las Vegas range and flows eastward to the Canadian. Its cañon becomes close at a little way south from Fort Union, and thence to the Canadian the river flows at the bottom of a gorge with bold vertical walls, becoming higher as the stream descends, until at the mouth of the cañon they rise to 1090 feet above the "bottom," where some half savage Mexicans gain a scanty livelihood by cultivating little patches of corn and melons.

Both cañons have the hard Upper Dakota sandstone as their rim, and that rock is the surface rock of the plains between the cañons, where a few relics of the Middle Cretaceous beds remain, protected by a plate of basalt which covers the Low Mesas or Table hills.

An extinct volcano, at 7 miles east from Fort Union, forms the southern extremity of the Turkey mountains—the Gallinas hills of Dr. Newberry's San Juan report—a curious qua-qua-versal, which deserves much closer study than could be given to it by either Dr. Newberry or myself. The volcano has been visited by Dr. Newberry, Dr. LeConte, Dr. Hayden and the writer. The crater still retains its form and the rim is broken only on the southern side, an imperfection due, perhaps, in some measure to erosion, but in greater part to the pressure of the lava. The eruption to which this mountain owes its origin occurred in the later Tertiary, and the lava is basaltic.

The basalt extends northward but a very little distance and the flow was toward the south through the breach in the crater. The lava was followed from the breach directly to the Mora cañon, the passage beginning along an arroyo or dry water course, where the basalt rests on Upper Dakota sandstone, though occasionally a little débris intervenes. At one locality, some tufaceous limestone, characteristic of the Santa Fé Marls, belonging to the Loup River epoch, is included in the débris.

Entering the Mora cañon, the basalt followed the gorge to its mouth, and was in such volume as to flow up the Canadian cañon to a distance of near-

ly three miles. How far it went below the mouth of the Mora cañon was not ascertained. The continuity of the flow is distinct throughout and the general features of the rock in the Canadian cañon are the same with those observed in the crater itself.

A solid crust forms quickly on the surface of cooling basalt. It is probable, therefore, that the Mora river was not long displaced; but that it, as well as the Canadian, soon regained its channel and began once more the work of corrasion. The features shown in the cañons are of no small interest, for the extent of erosion prior to the basalt flow is as clearly exhibited as is the extent of the erosion since that event. The features are best studied in the Mora cañon, at the mouth of which the following measurements were obtained:

1. From river surface to bottom of basalt..... 230′
2. " same to top of basalt..... 620′
3. " " brink of the chasm..... 890′
4. " " top of wall.....1090′

The chasm is therefore 230 feet deeper than when the basalt flood took possession of it.

As the present cañons do not wholly coincide with the ancient gorges, the numerous curves exhibit the base of the basalt sheet very satisfactorily. The old valley of the Mora was benched or slightly terraced, so that the lava rests against a wall of sandstone, and overflows the bench of which that is the escarpment, as is shown in fig. 1:

Fig. 1.

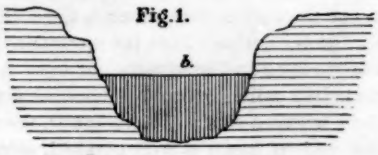


FIG. 1.—Showing form of the ancient cañon. *a.*—Dakota sandstone. *b.*—Basalt.

A breccia frequently appears in the bottom of the sheet, as though the molten rock had caught up débris in its flow.

The basalt terrace at the junction of the cañons indicates that the ancient cañon of the Canadian was much wider than that in which the river now flows.

The south-west wall of the old cañon lies at nearly a mile further from the river than does the present wall, which is capped by the sheet of basalt. It is very evident that before the basalt outpouring occurred the cañons had been digged down at their junction to 860 feet below the present level of the plain, and that the depth was reduced to 470 feet by the influx. But since the streams regained their channel-ways, material to the depth of 620 feet has been removed by corrasion; so that the vertical cutting since the flow ceased is very nearly equal to that done before the flow began. This cutting is wholly the result of corrasion, the wear of the streams upon their beds.

The enormous erosion on the plains and in the tributary cañons must have antedated the Turkey Mountain eruption. The basalt rests on the Dakota sandstone between the crater and the Mora cañon; it has flowed into the tributary cañons, where it still remains; the stream is almost wholly continuous across the plain; the surface of the sheet is scarcely scarred in the side cañons; while on the terraces of the Mora cañon and on the broad terrace between that and the Canadian cañon, the surface is as regular as though the flow had occurred less than 100 years ago. Such facts make it sufficiently clear that since the Turkey Mountain eruption, the rainfall has been comparatively insignificant. But this season of dryness must have been preceded by one of much greater rainfall, unless, indeed, we conceive that the erosion had been continuing for an indefinite period. But a moment's consideration will show that such a continuance is impossible; remnants of the Colorado shales remain on the plains as mesas nearly 1000 feet high, which have been protected from erosion by a thick plate of basalt. This plate, which covers the Canadian hills east from the Turkey mountains and is an outlier of a vast basaltic area, marks the occurrence of a previous outpouring, not earlier than the beginning of the Pliocene. The enormous erosion, then, must have been performed during the interval between the eruptions, which, in a geological sense, could not have been very long. There seems, therefore, no room for doubting that a great climatal change passed over this region; that during the interval between the eruptions the rainfall was great, sufficing for the removal of the thick Colorado group and the digging out of the many imposing arroyos or side-cañons, but that since the later Pliocene the region has been arid, the corrasion of the cañons having been done by water drained from the mountains.

But the new cañons do not coincide with the old ones. A small bit of basalt caps a hill in the Canadian cañon, at somewhat more than 2 miles above the mouth of Mora river; within a short distance lower, the cañon bends westward, and the thick bed of basalt is well exposed, covering a terrace on the south wall; soon the gorge curves southward and becomes very narrow as it passes through the basalt, which caps both walls, its base being nearly 200 feet above the stream. But within one-fourth of a mile, a slight bend eastward carries the cañon beyond the basalt, which now lies only on the western wall and covers a bench, stretching thence to the cañon of Mora river. A fragment of basalt remains in the former cañon on an isolated hill almost immediately below the mouth of Mora.

The present cañon of Mora river has the basalt altogether on its northeasterly side for a distance of nearly a mile and a half, and a fragment of the old westerly wall still remains as an irregular conical hill, rising above the basalt terrace. At a little way above this, the basalt has been wholly eroded from both sides of the cañon, excepting only an insignificant and badly broken patch on the south side; but immediately above this, the gorge becomes close, and the basalt is shown on both sides.

It is evident, then, that the cañons have been re-eroded partly along the original line or through the basalt, and partly alongside of the ancient

chasms, the basalt appearing sometimes on one side, sometimes on the other, and occasionally on both sides. One may easily determine whether or not the cañon is wholly beyond the limits of the ancient gorge, since if it be, the wall is sheer to the top; whereas, if the course be along the old channel-way, and the absence of the basalt be due to erosion, the bench previously covered by the lava is still distinct. The cross sections exhibit the features very satisfactorily; thus in passing from one cañon to the other at a little way above the junction, one would find the condition shown in Fig. 2.

Fig. 2.

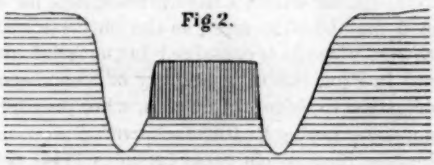


FIG. 2.—Section across cañons of Canadian and Mora rivers near their junction.

The basalt covers the level bench between the two cañons, while the higher wall of each is composed from top to bottom of the Dakota rocks. But at a mile and a half further up the streams the structure is as shown in Fig. 3 where the basalt appears on both sides of each cañon. Here both

Fig. 3.

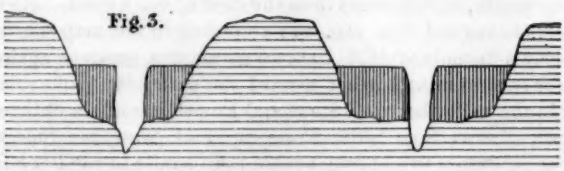


FIG. 3.—Section across cañons of Canadian and Mora rivers, two miles above their junction.

streams have cut their way through the basalt, whereas in the other, both cañons are outside of the sheet.

This new channel-way has been digged out of rocks of unequal hardness, and the corrasion seems to have gone on with equal rapidity everywhere. The gorge is as deep where the basalt plate appears in both walls as it is where the basalt is on one side or wholly away from the cañon. The only observable difference is that, where cut through the basalt, the cañon is very narrow, and the cutting has been confined to the immediate channel-way; whereas, the gorge is wide and shows a "bottom" where it has been worn in the sedimentary rocks only. The Canadian and the Mora are exceedingly rapid and very imperfectly loaded. Their corrasive power is far greater, therefore, than might be supposed, if their volume alone were considered.

Notes on the Geology of Wise, Lee and Scott Counties, Virginia. By John J. Stevenson, Professor of Geology in the University of the City of New York. (With three wood cuts.)

(*Read before the American Philosophical Society, August* 20, 1880.)

During the winter of 1880, General J. D. Imboden discovered valuable coal beds near the Big Stone gap in Wise county, Virginia, at about sixty miles from the Tennessee line. The property soon passed into the hands of Northern capitalists, for whom I have investigated its economic value. The facts obtained may be of interest, as the only attainable information respecting Southwest Virginia is contained in the brief memoirs by Prof. J. P. Lesley* and in Prof. Safford's Geology of Tennessee. I am under very especial obligation to General Imboden, who, previous to my arrival, had studied the general geology with much care.

The area to be described in this paper includes those portions of Wise, Lee and Scott counties which are drained by the forks of Powell river and by the North Fork of Clinch river. Its north-western boundary is Black mountain, a ridge of the Cumberlands, which here forms the line between Virginia and Kentucky. At some distance from the Tennessee line, Stone mountain separates itself from that mountain and follows a N. 56° E. trend for about fifty miles to the Little Stone gap, where it unites with Powell mountain, which comes from the west of south-west. No examination was made beyond that gap, but, according to the map accompanying Prof. Lesley's memoir of 1872, the two mountains separate again and are distinct for several miles further toward the east. Wallen's ridge begins midway in the valley between Stone and Powell mountain at three or four miles south of west from Little Stone gap, and continues rudely parallel with Stone mountain to somewhat more than a mile beyond the Big Stone gap. There it is divided by a narrow valley into Wallen's ridge and Poor Valley ridge, which continue beyond the State line into Tennessee.

Two forks of Powell river, known as Pigeon and Roaring, rise on the southern slope of Black mountain and unite at the head of the Big Stone gap. The South Fork rises in the valley between Powell mountain and Wallen's ridge, flows through the eastern extremity of the latter and unites with the river at barely a mile below the Big Stone gap. The North Fork of Clinch river rises in the valley between Wallen's ridge and Powell mountain and breaks through the latter mountain at the North Fork gap, which is about twenty-five miles south-west from the Little Stone gap. Thence it flows eastwardly to Clinch river.

Two lines of section were followed; one beginning on the crest of Stone mountain, at say a mile west from the Little Stone gap and crossing the valley to the crest of Powell mountain; the other beginning at Black mountain and continuing southward through the Big Stone gap, across both Poor Valley and Wallen's ridges to the south-eastern side of Powell

* Proceedings of this Society, 1862 and 1872.

mountain. Unfortunately, there was no opportunity to make accurate measurements of horizontal distances and the scale of the cross-sections is probably somewhat distorted. In neither case was Powell mountain crossed along the line of section and the details respecting its southern side are taken from features observed in the North Fork gap.

The western section is shown in Fig. 1.

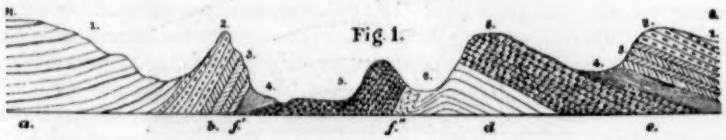


FIG. 1.—Cross-section from crest of Black Mountain to south-eastern side of Powell Mountain. *a*, Black Mountain; *b*, Stone Mountain; *c*, Poor Valley Ridge; *d*, Wallen's Ridge; *e*, Powell Mountain; *f'*, Stone Mountain fault; *f''*, fault of Poor Valley Ridge. 1, Coal Measures; 2, Conglomerate; 3, Lower Carboniferous; 4, Devonian; 5, Upper Silurian; 6, Lower Silurian.

Beginning at Black mountain, one finds himself amid the Coal Measures; going southward, he sees a slow but steady increase in dip until, as he approaches the Big Stone gap, it becomes nearly two degrees. But there the increase is very rapid, so that at the head of the gap the Seral conglomerate is dipping north-north-west at 80 degrees. The Lower Carboniferous limestone forms a bold cliff on both sides near the mouth of the gap and dips in the same direction at 70 degrees. Here a fault occurs, and one comes at once to *black shales* of unknown thickness, dipping in like direction at barely 20 degrees. Below these are the Lower Helderberg rocks, well exposed and of considerable thickness. On the south side of the Poor valley, and the northern slope of Poor Valley ridge, are the Clinton rocks with the fossiliferous ores, which continue to the head of Cedar gap, through which one comes to Turkey cove, separating Poor Valley ridge from Wallen's ridge. At the head of this gap, one crosses another fault and soon comes to the Trenton limestone, which is pressed into many short, close curves, but finally takes an almost due east dip on the northerly face of Wallen's ridge. The Medina sandstone is shown on the crest of that ridge, while the Clinton and Lower Helderderg rocks are well exposed in the valley between Wallen's ridge and Powell mountain. The black shales appear in the side of the latter ridge, with the Lower Carboniferous limestone higher up and the Conglomerate at the crest. On the opposite side of the mountain Hunter's valley is reached and there one finds the Coal Measures.

The other section, extending from the crest of Stone mountain to that of Powell mountain, is not more than seven miles distant from the other section, but it shows a great difference in the structure.

PROC. AMER. PHILOS. SOC. XIX. 107. L. PRINTED SEPTEMBER 9, 1880.

Here, beginning at Stone mountain, one finds as before the Coal Measures, Conglomerate and Lower Carboniferous forming that mountain; in the valley, the black shales are shown at the base of each ridge, while the Lower Helderberg rocks occupy the center of the valley, where they describe an anticlinal, exceedingly sharp near the axis, but showing much gentler dips on each side as Stone and Powell mountains are approached.

Fig. 2.

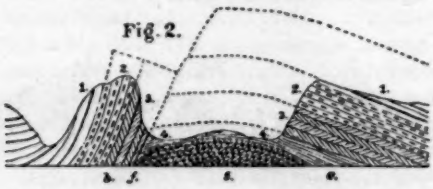


FIG. 2.—Cross-section from crest of Stone Mountain to that of Powell Mountain. The dotted lines show extent of material removed by erosion.

It is altogether probable from the best information attainable that a fault, rudely parallel to Stone mountain, exists in Kentucky at but a little way from the State line.

The general structure of the region between Black mountain and the Clinch river will be discussed in another part of this paper.

The Coal area between Black mountain and Stone mountain is extensive, but that within Hunter's valley is insignificant.

The Coal Area Drained by Pigeon and Roaring Forks of Powell River.

The Coal area, which begins immediately behind Stone mountain and extends thence to beyond the crest of Black mountain, is evidently the same with the Kentucky series, so well exposed in Harlan and Letcher counties of that State. The upper part of the Seral (Pottsville) Conglomerate forms the northern face of Stone mountain and the Coal Measures come in at the foot of the ridge, where the dip is very nearly vertical.

A series of barometrical observations shows that the series rises eastward from the mouth of Callahan creek, about a mile above the head of Big Stone gap. This rise of the whole region is rapid and is sufficient, if continuous, to carry most of the beds into the air within a few miles; so that only the lowest beds could be found at but a little way beyond the Little Stone gap.

For the most part, this region is still a wilderness, and exposures rarely occur except in the stream beds, which, owing to rapid fall, are usually clear. Several of the tributaries to Roaring fork were followed almost to their heads in the south-east side of Black mountain; and this general section was compiled from the measurements made on them.

1.	Not examined in detail	500′
2.	*Coal bed*	0′ 4″
3.	Sandstone	30′
4.	*Coal bed*	1′ 5″
5.	Sandstone and shale	115′
6.	*Coal bed*	0′ 6″
7.	Sandstone	70′
8.	*Coal bed*	2′
9.	Fireclay with stigmaria	2′
10.	Sandstone	12′
11.	*Coal bed*	1′
12.	Sandstone	70′
13.	Shale	20′
14.	*Coal bed*	0′ 4″
15.	Sandstone	26′
16.	Shale	4′
17.	*Coal bed*	0′ 10″
18.	Ill exposed, mostly sandstone	65′
19.	*Coal bed*	7′ 3″
20.	Sandstone	35′
21.	*Coal bed*	3′ 6″
22.	Sandstone	60′
23.	*Coal bed*	3′ 6″
24.	Ill exposed, mostly sandstone	120′
25.	*Coal bed*	Blossom.
26.	Sandstone	70′
27.	*Coal bed*	1′
28.	Shale and sandstone	22′
29.	*Coal bed*	extreme thickness 15′
30.	Sandstone	45′
31.	Shale	from 0′ to 5′
32.	*Coal bed*	extreme thickness 8′
33.	Shale	6′
34.	Sandstone	35′
35.	*Carbonaceous* shale	0′ 4″
36.	Sandstone	70′
37.	Ill exposed, mostly sandstone	65′
38.	Sandstone	30′
39.	*Coal bed*	2′
40.	Shale	10′
41.	Sandstone	40′
42.	*Coal bed*	2′
43.	Shale and sandstone	100′ ?
44.	*Coal bed* and shale	5′
45.	Interval to conglomerate	estimated at 80′
	Total	1751′

Exposures become poor near the top of Black mountain along all of the streams which were followed, and the upper part of the section was not made out. Sandstones and shales seem to be continuous for 200 feet above the highest *coal bed* seen in place; but there is certainly one *coal bed* within the undetermined interval beyond, as fragments of *cannel* were found abundantly at fully 200 feet up in that space. No limestone occurs in beds, but some nodular limestone was discovered within six feet above No. 17; and fragments of an exceedingly impure limestone, with a cone-in-cone structure in its more argillaceous portions, were found above No. 6.

Calahan creek is the main tributary of Roaring fork; its larger branches are known as Kelly's, Church House and Preacher runs. Looney creek is an important stream entering Roaring fork near its junction with Pigeon fork. On all of these, as well as on Pigeon fork, exposures were found, but the upper part of the section was obtained satisfactorily only on Preacher run.

The study was not sufficiently prolonged to admit of classifying the beds or of determining their relations to the groups recognized in Pennsylvania. There seems, however, to be a natural line of division about midway in the section: for, above the *coal bed*, No. 19, to within 250 feet of the top of the column, no thick *coal bed* occurs. It may be that the lower portion, for about 833 feet, is equivalent to the Lower Coal Measures of Pennsylvania as represented on the Great Kanawha river of West Virginia, and that the upper portion is equivalent to the Lower Barren Group of Pennsylvania. I have noticed in another place* the extraordinary thickening of the Lower Coal Measures southward; how this group, rarely more than 350 feet thick in Pennsylvania increases southward from the line of the Baltimore and Ohio railroad in West Virginia, until in Randolph county it is 700 or 800 feet thick. The increase continues southward and on the Great Kanawha the same group is upwards of 1200 feet thick.

On the Kanawha, the top of this group is distinct; for the "*flint ledge*," occurring in close proximity to the Mahoning sandstone, is a well-marked horizon. But on the headwaters of Powell river the "*flint ledge*" seems to be wanting, and no traces of it could be found. The division here, therefore, is arbitrary and a final determination of the matter must be postponed until opportunity has been had for less hurried investigation. It is quite possible that the full thickness of the group is not given in the section, as the lower intervals were merely estimated.

If the top of the Kanawha series be at *coal bed*, No. 19, some representative of the Upper Productive Coal Series of Pennsylvania may be sought near the crest of Black mountain; for while the Lower Productive Coal Series shows the remarkable increase southward, the Lower Barren Group shows no such increase. Its extremes are 500 and 700 feet, both of which may be found within the limits of a single township in different parts of Pennsylvania. No system of variation in this group has been discovered,

* Proceedings of this Society for 1875. Notes on Geology of West Virginia, No. II.

possibly because the group possesses comparatively little economic importance, so that it has received less study than has been given to the other coal groups of Pennsylvania. But the close investigation, which Mr. W. G. Platt has been making of this group for the Pennsylvania Geological Survey may remove the obscurity.

The *coal bed*, No. 19, as exposed on Preacher run, has the following structure:

1. *Cannel*	2′	
2. Shale	0′ 4″	
3. Slaty *coal*	0′ 4″	
4. Shale	0′ 5″	7′ 3″
5. *Coal*	0′ 5″	
6. Shale	0′ 4″	
7. *Coal*	3′ 5″	

The *cannel* is compact and much like that which is obtained in Armstrong county of Pennsylvania. It contains many fragments of sandstone, whose presence seems to indicate that the material of which the *coal* was made was pulpy, not like that which accumulated to form the ordinary beds. No distortion of the *coal* appears, such as was seen about the large fragment which I discovered* in the *Sewickley coal bed* in Fayette county, Pennsylvania. The fragments are small and angular, and doubtless they were attached to some tree, which had been uprooted during a freshet. The same bed was seen on Calahan creek, where it shows:

Coal	0′ 5″	
Shale	10′	
Coal	1′ 2″	19′
Shale	7′	
Coal	0′ 5″	

and is therefore worthless.

Coal bed, No. 21, is exposed on Preacher run and Calahan creek, and fragments of it were seen on Looney creek, though the bed itself was not found. On Preacher run it is finely shown at two miles from the mouth of the stream, where it is from 3′ 6″ to 3′ thick and yields a *splint coal* of remarkably fine quality. The roof is a hard, compact sandstone and the *coal* shows but insignificant partings. An analysis of this coal by Mr. A. S. McCreath, of the Penn. Geol. Surv., gave

Water at 225°	0.880
Volatile matter	37.580
Fixed carbon	58.059
Sulphur	0.406
Ash	3.075

* Second Geol. Surv. of Penn. Rep. on Fayette and Westmoreland counties. [KK.] p. 216.

This *coal* is well adapted for use in the furnace, as it has an extremely low percentage of sulphur and ash. The analysis just given may be compared with one of the *Sharon* or *Block coal*, which is used extensively in the iron works of eastern Ohio. This is also by Mr. McCreath, and is given in Report MM of the 2d Geol. Surv. of Penn., p. 99.

Water at 225°	3.790
Volatile matter	35.300
Fixed carbon	53.875
Sulphur	0.675
Ash	6.360

Coal bed, No. 28, is very similar to the last. It is 3′ 6″ thick on Preacher run, but is 4′ 6″ on Looney creek. It is persistent throughout the area examined and holds its thickness well.

Only the blossom of No. 25 was seen. No. 27 is persistent but always thin. Lying as it does between two plates of hard sandstone, it is often useful in indicating the place of the large bed below.

Coal bed, No. 29, is exceedingly variable, though altogether persistent. It has been opened on Pigeon fork at probably two-thirds of a mile above the mouth of the stream, where it shows:

Coal	6′ 10″	14′ 10″
Shale	0′ 10″	
Coal	2′ 5″	
Shale, averaging	0′ 3″	
Coal	4′ 6″	

A similar structure was seen on the first branch of Pigeon fork, and at both localities the upper division is so slaty as to be apparently of little value. The middle division is soft, has a prismatic structure and cokes well; the lower division is, for the most part, a splint coal of very fair quality, though it is somewhat inclined to be slaty near the base. On Looney creek, only the middle and lower divisions remain, the upper division having been removed by a horseback of clay. The character of the remaining divisions is the same as on Pigeon fork, but the *coal* is more liked and that from the middle division is carried to long distances for use by blacksmiths. Eastward from Looney creek, the bed is exceedingly variable; on Preacher run it is but two inches thick, on Kelly's run it is insignificant, and on Church House run it seems to be not more than one foot. But at an exposure near Roaring fork, at about two miles above the head of Big Stone gap, the bed is evidently very thick, though the exposure is too indefinite to admit of definite measurement. At all localities the lower parting shows many impressions of *Sigillaria* and *Syringodendron*.

As the middle division of this bed seemed to be a good coking *coal*, a sample was forwarded to Mr. McCreath for analysis. Its composition is:

Water at 225°	1.610
Volatile matter	38.850
Fixed carbon	57.879
Sulphur	0.771
Ash	0.890

which shows it to be a gas coal of superior quality. The coke, in point of ash, cannot be excelled.

Coal bed, No. 32, is the most important and least variable bed of the series and it is likely to prove of great economical importance, as it will afford *coke* for working the vast deposits of iron ore which exist along the line of the Atlantic, Mississippi and Ohio railroad and in Northwestern North Carolina. It was seen on all of the streams except Looney and Calahan creeks, the place of the bed being concealed on those streams where the water runs over it. A line of springs marks its outcrop on Pigeon fork and the *coal* is exposed on the first branch of that fork. An imperfect opening on Church House run shows :

Coal	3′ 10″	7′ 9″
Shale	0′ 5″	
Coal	3′ 6″	

The top part of the bed for eleven inches is very hard, a true *splint*, which is an advantage, as the roof is not always secure ; but the remainder of the upper bench is very soft and much of it has a prismatic structure. The lower bench is somewhat less soft, but is very tender. The *coal* taken out at this opening cokes well. An exposure near the mouth of Preacher run shows :

Coal	2′ 8″	6′ 11″
Parting	—	
Coal	1′	
Shale	0′ 3″	
Coal	3′	

At a mile further up the run, the bed has the same structure, but is only 6′ 9″ thick. The coke made at the latter opening is very hard, porous and silvery. On Kelly's run the bed is somewhat thicker and shows :

Coal	4′ 5″	8′ 5″
Shale	0′ 3″	
Coal	3′ 9″	

But the character of the exposure is not such as to indicate the quality of the *coal*. The same bed is shown on a little branch of Roaring fork, where it is not far from eight feet thick. *Sigillaria* and *Syringodendron* impressions are numerous in the shale parting.

To determine the quality of the *coal*, samples were taken from all the benches except the hard *splint coal* on top. These yielded the following on analysis by Mr. McCreath :

Water at 225°	1.380
Volatile matter	35.920
Fixed carbon	60.591
Sulphur	0.594
Ash	1.515

It is therefore a *coking coal* of marvelous excellence. The coke will contain less than three per cent. of ash and barely a half per cent. of sulphur. This coke is far superior to that from the Connellsville region, and better than that from the Oxmoor Works in the Cahawba basin of Alabama. It is decidedly better than the coke from the New River region of West Virginia.

No. 39 is a persistent though valueless bed. It has been mined near the mouth of Church House run, where it is two feet thick and yields an inferior *splint coal*, which is very rich in sulphur. Its blossom appears in the bluff above the road alongside of Roaring fork for nearly two miles above the head of Big Stone gap.

The interval, No. 37, could not be made out. The whole face of the coal-area fronting on Roaring and Pigeon forks is injured by extensive slides, which conceal this interval everywhere.

No. 42 was seen above the mouth of Calahan creek in the bed of Roaring fork, and in the bed of Pigeon fork at probably a mile above its mouth. The *coal* is said to be very good, a condition due no doubt to the removal of its sulphur by the water.

The remainder of the section was not measured. The lower members rise quickly toward Stone mountain and the rate of dip varies so greatly that thicknesses could not be determined during a mere reconnaissance.

The Seral (Pottsville) Conglomerate.

The Conglomerate forms the northern side of Stone mountain and its cliffs dip N. N. W. at between 70 and 80 degrees. The intervals between these cliffs must be occupied by shales or very soft sandstones as they afford no exposures. The group as shown in the Big Stone gap is not less than 1000 feet thick, but, owing to the dense forest, it was impossible either to gain a general section or to get the detailed structure of any portion. It was not determined, therefore, whether or not the Quinnemont series of *coal* beds is present here. This cannot be ascertained until the foliage has fallen.

The sandstones in the cliffs vary from fine-grained to coarse conglomerate, the latter containing quartz pebbles as large as a pigeon's egg. The highest bed is a moderately fine-grained rock and is well shown at the head of the gap, where it dips at 80 degrees. This is known as the "Bee-rock," as the laurel blossoms covering it are the resort of immense numbers of bees during the early summer. It shows many rude impressions of *Sigillaria* and extends along the north face of Stone mountain to beyond the Little Stone gap.

The Lower Carboniferous.

Like the Conglomerate, these rocks are found only in the mountains, and details respecting their thickness and composition cannot be ascertained until after the foliage has disappeared. They are shown along the south face of Stone mountain from Little Stone gap westward to the Tennessee line, and on the northerly face of Powell mountain from that gap to the North Fork gap, where the Carboniferous series ends. The Umbral Limestone follows the left hand side of the gap until within a short distance of Clinch river.

No detailed exposure of the interval between the Conglomerate and the Umbral Limestone was discovered, but it is not far from 500 feet thick, and appears to be filled chiefly with red shale, of which a few short exposures were seen.

The limestone appears as a cliff along the southern face of Stone mountain and is well shown on both sides of Big Stone gap, where it dips N. N. W. at 70 degrees, and, as nearly as can be estimated, is between 250 and 300 feet thick. The turnpike is cut through it at Little Stone gap. Thence, along Powell mountain, it is seen as a broad band to the North Fork gap, where its outcrop bends eastward and follows the left hand side of the gap almost to Clinch river. For the most part, this rock is compact and fine grained, but some of the beds are granular. Chert, in nodules as large as an ordinary orange, is plentiful in one layer. Fossils occur throughout the mass, but the specimens are not silicified and the species are not readily identifiable. *Productus cora* and *Zaphrentis spinosa* were obtained near the mouth of Big Stone gap. Many layers of this limestone are very pure and yield a lime of superior quality. The rock is cavernous and the large caves in Powell mountain afforded a supply of saltpetre to the Confederates during the late war.

Whether or not rocks of *Vespertine* age have been brought up along the face of Stone mountain was not ascertained; but the position of the limestone at a few miles west from the Big Stone gap renders probable that no representative of that group has been brought up. On the northerly face of Powell mountain, however, the succession is unbroken and the Vespertine rocks are undoubtedly present there, although they are concealed. A *coal* bed exists in the North Fork gap at a considerable distance below the limestone and therefore belongs to this group. *Coal* from it was used at a catalan forge in the gap.

The Devonian Rocks.

The immense Devonian series of New York and Pennsylvania is insignificant here and is represented only by *black shales*, which are exposed along the foot of both Stone and Powell mountains. These shales cross the valley near Little Stone gap, where their dip is abrupt near the central line of the valley, but becomes gentler toward each mountain. They are the equivalent of Prof. Safford's "*Black shales.*" Their thickness was not determined accurately, but it cannot exceed 500 feet. No fossils were found in them.

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The Upper Silurian Rocks.

The Lower Helderberg, the Clinton and the Medina were recognized.

The Lower Helderberg.—The rocks of this group are exposed in the Poor valley; on the eastern end of Wallen's ridge; in the valley between Wallen's ridge and Powell mountain; in the North Fork gap, and on the south-eastern slope of Powell mountain beyond that gap. The exposures are very fair and a complete section could be obtained without much difficulty.

The estimated thickness is not far from 250 feet. For 70 feet from the bottom the series consists of limestones in beds of from three to five feet, separated by shales in somewhat thicker layers. The lower limestones are silicious, but, toward the top, the beds are purer and one of them, black, fetid and four feet thick, contains abundance of *Leperditia*. Overlying this is a succession of coarse-grained calcareous sandstones, shales and silicious limestones, not well exposed along the line followed in the attempt to secure a section. The lower calcareous sandstone is shown in a line of low hills near Big Stone gap, and also on the turnpike within a mile of Cedar gap; the larger of the silicious limestones is shown near the pike opposite the gap, and also on the north side of Powell river at barely a mile below the gap. It is very light in color and has a cherty look. Immediately above it is a coarse reddish-gray sandstone, closely resembling the Oriskany sandstone of New York.

The lower sandstone is well shown on the pike, where it seems to be made up almost wholly of casts of *Orthis oblata*, *Rhynchonella ventricosa*, and undetermined *Meristella*.

The silicious limestone yielded *Crinoid stems*, abundant; *Aspidocrinus scutelliformis*; *Chætetes*; *Favosites*; *Atrypa reticularis*; *Strophomena rhomboidalis*; *Strophodonta*; *Spirifer cyclopterus*; *Meristella*; *Rhynchonella nucleolata*; *Orthis oblata*; and other forms which were not recognized.

The immediately overlying sandstone has a broad *Meristella*; *Spirifer perlamellosa*; *Favosites*; *Caninia helderbergiæ*; the last two in great abundance.

At some distance up the valley, say four miles above the Big Stone gap, on property belonging to Mr. Spencer, the upper silicious limestone becomes impregnated with brown hematite. Usually only the joints have been filled, but occasionally for considerable distances the rock has been replaced by limonite. The ore is too silicious to be of any value. The fossils are distinct. Along the valley between Wallen's ridge and Powell mountain, the Lower Helderberg rocks can be followed easily; the silicious limestone and the lower calcareous sandstone have been replaced to a greater or less extent by brown hematite. The outcrop of the lower ore follows the hillside above the road for miles, while the upper bed follows the creek-bottom almost to the head of Wildcat creek. Much of the ore at the upper horizon is exceedingly poor, but there are some pockets of decidedly good material. The fossils are the same with those seen at the same horizon in the Poor

valley. The lower horizon makes a fine showing along the hillside and the fragments that have fallen to the road are often of such excellent quality that a passing observer might be led to suppose that the deposit is of uniformly good quality. Unfortunately, the ore here, as at every other locality, is variable. Much of it is merely the sandstone permeated with limonite, sometimes half its bulk being ore. There are, however, numerous pockets, some of them very large, which contain ore of marked excellence, as appears from the following analysis by Mr. McCreath :

Metallic iron	52.550
Sulphur	0.037
Phosphorus	0.051
Insoluble residue	7.840

Thus containing only .097 of phosphorus in 100 parts of iron.

This hematite occurs on the south-east face of Powell mountain beyond the North Fork gap, but no examination was made there to determine its extent or quality.

The Clinton Group.—In the low hills alongside of the turnpike and opposite the Big Stone gap, the following succession of the rocks underlying the Lower Helderberg was made out.

1. Mostly concealed, with here and there an insignificant exposure of sandstone ; probably contains some pure limestone, as fragments were seen on the surface. Estimated at ..... 250′
2. Red to yellow fissile shales, with thin layers of fine grit. Dip almost vertical ..... 60′
3. Imperfectly exposed ; has occasional layers of reddish grit ..... 35′
4. Fine grained calcareous grit, passing downward into silicious limestone. The upper half contains little calcareous matter and is very hard ; but toward the base, the rock becomes comparatively good limestone. No fossils were seen. The dip at the top is 70 degrees, but decreases downward, becoming 56 degrees at the base ..... 60′
5. A concealed interval ..... 75′
6. Deep red flaggy sandstone, very fine-grained and exceedingly hard ; dip is 30 degrees toward N. N. W. This rock contains many *Fucoids*, but no other fossils were seen except a weathered cast of *Orthoceras* ..... 8′
7. Shales, red to yellow, brittle, with thin layers of hard shale containing *Fucoids*. The dip is indistinct .... 50′
8. Silicious limestone, not unlike that seen in the Lower Helderberg ..... 5′

Below this, the succession is very indistinct along the three lines on which a section was attempted. The cherty limestone contains many fossils, but they are not well preserved, and the species are indistinct.

Below the rocks of the section is a series of shales and sandstones, in which are found the fossil ores of this group. No estimate of the whole thickness was made.

The Clinton rocks are well shown on the south side of Poor valley, and from the northern face of Poor Valley ridge. They occur on the north side of Wallen's ridge above the mouth of South Fork of Powell river, and are well exposed along the southerly face of that ridge for several miles. They appear also on the south-easterly slope of Powell mountain beyond the North Fork gap. At all of these localities the fossil ores are found.

Three beds of ore were seen in the Poor Valley region. The highest belongs probably within the concealed interval No. 7 of the section. It shows itself in the bank of Powell river at about half a mile from the gap with a thickness of from 5 to 8 inches, and a dip of 56 degrees toward N. 25° W. It is included in greenish shales, which are rich in *Fucoids*.

The second bed crops out in the "bottom" at say half a mile further down the river. It is important, and has the following structure:

Hard ore	4′ 8″
Soft ore	2′ 6″

The upper layer has very fair ore in its lower 20 inches, which could be used in a furnace. It is harder than the tender fossiliferous ore below, and contains fewer fossils, but it is much less hard than the other part of this layer. The strike is N. 40° E., and the dip is 45 degrees. The bed was followed for a considerable distance, but no material variation in thickness was observed.

A third bed was seen near Cedar gap, but the exposure there is somewhat indefinite. The hard ore predominates, and is far from being good.

The last two beds occur on Wallen's ridge at but a little way above the mouth of South Fork of Powell river.

Two beds only were seen on the south face of Wallen's ridge along Wildcat creek, a tributary to the South fork. One of these is 25 inches thick, and dips at 10 degrees in an almost east direction. The other bed shows:

Soft ore	2′
Hard ore	2′ 2″

overlying one foot of ferruginous shale, which rests on a flaggy sandstone. The upper part of the soft ore is almost granular, and can be removed with a shovel, but it is inferior to the other part, and contains many small rounded quartz pebbles. The hard ore shows very few fossils. The dip is 11 degrees and almost due east.

The ordinary ore of this region is very good, as appears from the following analysis by Mr. McCreath, of a specimen from Wallen's ridge:

Metallic iron	52.600
Sulphur	0.018
Phosphorus	0.116
Insoluble residue	18.140

there being but .220 of phosphorus in 100 parts of iron.

The very soft or granular ore was analyzed. It has the same character as the last, except that, owing to the presence of the quartz pebbles, the insoluble residue is very great. The proportion of phosphorus is .228 in 100 parts of iron.

Three beds were seen in the area along the south-east slope of Powell mountain beyond the North Fork gap. The highest one is thin and contains only silicious ore. The second bed shows:

Ore	1′
Shale	1′
Limestone and Ore	0′ 5″
Shale	0′ 4″
Ore	0′ 5″
Shale	0′ 4″
Ore	1′

At 50 feet below this, the interval being filled with sandstone, another bed was seen showing:

Very soft ore	1′ 3″
Hard ore	1′ 6″

The ore in both of these beds is leaner than that seen in Poor valley and on Wallen's ridge, but it can be mined very cheaply. These Powell mountain ores show the fossils much more distinctly than do those in the other localities and the forms are larger. *Leptocœlia hemispherica*, *Streptorhynchus subplana* and the pygidium of a *Calymene* occur abundantly.

The Medina Sandstone.—This was seen only on the crest of Wallen's ridge near the head of the valley separating that ridge from Poor Valley ridge. It is a moderately coarse, light gray sandstone, evidently more than 300 feet thick, and so far as observed contains no fossils.

The Lower Silurian Rocks.

No rocks of this age appear in the Poor valley within at least 15 miles west from the Big Stone gap; nor are they exposed between Wallen's ridge and Powell mountain between North Fork and Little Stone gap; nor do they come to the surface along the south-east slope of Powell mountain beyond that gap. But they are well exposed on the northerly face of Wallen's ridge and in Wallen's valley, which separates that ridge from Powell mountain beyond the North Fork gap.

Limestone is the prevailing rock and there is little reason to believe that even the base of the limestone of II is reached at any exposure within the area examined. With the limestone, shale is interstratified, which is sometimes fissile but often compact and not laminated. One cannot fail to note

the deep red color of the débris covering the outcrop of the limestone, which so often resembles the decomposed outcrop of a limonite bed.

In Wallen's ridge the limestone has an almost east dip, but in the valley between that ridge and Poor Valley ridge it is pressed into very close abrupt folds, in which the dips sometimes exceed 60 degrees. In these folds, too, the dip is twisted, so that instead of being east and west, it becomes first N. W. and S. E., and then N. N. W. and S. S. E. The lowest member of the series is a mass of reddish to yellow shales, which are so distorted that their thickness could not be determined. These, however, are probably only a part of the limestone series.

Whether or not any shales intervene between the limestone and the Medina sandstone above, was not ascertained, as a concealed interval occupies the space between the two formations. These rocks do not come to the surface again toward the east until near Clinch river, where Stock creek has eroded a tunnel through a hill of the limestone. In the limestone of Wallen's ridge, *Strophomena alternata*, *Leptæna sericea*, *Orthis occidentalis* and other species characteristic of the Trenton limestone occur abundantly.

General Structure of the Region between Black Mountain and Clinch River.

The following diagram, Fig. 3, which is a continuation of Fig. 1, represents the structure of the region between the fault of Poor Valley ridge and Clinch river:

Fig. 3.—From Poor Valley Ridge to Clinch River. *g.*—Hunter Valley.

The Stone Mountain Fault is the "Clinch River uplift" of Prof. Lesley, which, according to his map of 1872, continues far toward the east and throughout its entire course is the southern and south-eastern border of the coal field.

The fault to which the mountain is due is sharp; the Umbral limestone on its southern face dips at 70 degrees; the Seral conglomerate, at more than 80 degrees; but the dip decreases with great rapidity, diminishing from 80 to 2 degrees within a very few rods and soon becoming less than 1 degree. Only the lowest rocks of the coal measures are involved in this abrupt dip and of those the projecting portions have been removed by Pigeon and Roaring forks of Powell river within the area visited.

Looking across the valley from Stone mountain to Powell mountain, one sees at once the relations of the Stone Mountain fault; for the Poor Valley Ridge fault is represented there only by a gentle anticlinal. The conditions are as shown in Fig. 2, where the dotted lines represent portions which have been removed by erosion; the whole section, as given in the diagram, is pre-

served at the head of the South Fork of Powell river, where the divide between that stream and the West Fork of Stone creek joins the two mountains. The figure exhibits the fact that here there is a cracked anticlinal, with the crack at some distance north from the line of the axis. The succession of the rocks on the south side of the axis is continuous from the Lower Helderberg to the Coal Measures, the latter being present in Hunter valley, on the southerly side of Powell mountain; but on the north side of the axis the succession is broken, and the Black Shales of the Devonian rest against the upturned beds of the Lower Carboniferous. It is evident that during the plication of the rocks the beds gave way, and that the lateral shove was so strong as to push those on one side of the fracture into an almost vertical position, while those on the other side were simply raised or perhaps pushed over on to the upturned edges of some lower rocks, which are not shown at the surface along the line of the fault. It is altogether probable that the rocks now occupying the valley along the southern foot of Stone mountain rest on beds of Vespertine age.

The vertical extent of this fault is less than one might suppose, and doubtless is little more than 6000 feet. The Devonian is represented here only by black shales, which are of inconsiderable thickness when compared with the great mass of Devonian rocks in New York and Pennsylvania. If erosion had not removed so much material along the Powell river and its tributaries, one might have found throughout only the condition indicated by the dotted lines in Fig. 2; and the vertical extent of the fault would have been regarded as altogether insignificant, for the Lower Carboniferous limestone is practically in contact on both sides of the fault in the vicinity of the Little Stone gap.

The Fault of Poor Valley Ridge.—A petty anticlinal exists between Powell and Stone mountain in the valley near the Little Stone gap. Its dips are more abrupt on the northern than they are on the southern side, while at the same time they are much more abrupt near the axial line than they are at a little distance from it. Only the Devonian and Lower Helderberg rocks are brought to the surface in the valley here.

At but a little toward the west a crack appears in this anticlinal and soon develops into the well-marked fault of Poor Valley ridge, which is approximately parallel to the Stone Mountain fault and lies at say three miles S. S. E. from it. Erosion has been actively at work along the southerly side of this fault and has divided Wallen's ridge into Poor valley ridge and Wallen's ridge, the separation first becoming distinct at Cedar gap, somewhat more than a mile below the mouth of the South Fork of Powell river.

As the two faults are approximately parallel, the dips are the same in direction on the northern side of both; but on the southerly side of the Poor Valley Ridge fault, the dips are almost due east, as is well shown at the head of Turkey cove. Entering this valley from the north by way of Cedar gap, one finds the structure represented in Fig. 1. The Clinton rocks on the north side of the fault strike N. 70° E. The Lower Silurian rocks, on the opposite side, which have been shoved into closely compressed

folds, have at first N. N. W. and S. S. E. dips; but within a very short distance the direction changes to N. W. and S. E.; and the veering toward the east continues until, on the side of Wallen's ridge, the great Trenton limestone dips at N. 80° E., very nearly the same as the strike of the Clinton rocks. Dips of 30 to 60 degrees are common enough on the northern side of the fault, but on the southerly side they seldom exceed 10 degrees.

The fault of Poor Valley ridge is evidently a cross fault. It continues into Tennessee and is crossed by Powell river.

The Region between Wallen's Ridge and Clinch River.—Wallen's ridge and Powell mountain are one in structure; the valleys separating them are monoclinals; and the beds shown on Powell mountain reached at one time to the crest of Wallen's ridge, or better, perhaps, to the fault which is the southerly line of the Poor Valley ridge. No detailed examinations were made beyond Powell mountain; and the notes were obtained only while passing along the Estilville road from the head of North Fork gap to Clinch river. Some details respecting the conditions existing within a few miles further north-east were received from General Imboden, who had crossed Powell mountain into Hunter's valley.

If the reader will consult the map accompanying Prof. Lesley's memoir of 1872, he will see that Powell mountain curves somewhat sharply toward the south-east near the western edge of the map. This bend is due to erosion by a branch of the South Fork of Powell river, and marks no change in geological structure. A similar bend occurs at the North Fork, which is due to erosion by the North Fork of Clinch river.

There appears to be a general uplifting of the whole area south-westward; for the dips grow gentler in that direction, and the synclinal between Wallen's ridge and Clinch river seems to grow shallower. The axis of elevation curves toward the south-west not far beyond the North Fork gap, and the dip on the slope of Powell mountain becomes south-east. The Carboniferous rocks do not extend beyond the North Fork gap; and thence, as far as was examined, only the Upper Silurian rocks are shown on the slope of the ridge; nothing newer than the Devonian black shales is present along the North Fork of Clinch river after it leaves the gap. Possibly the absence of the later rocks may be due in large measure to erosion. The Carboniferous rocks are well shown on the north-eastern side of the pass, until within two or three miles of the Clinch river. The axis of the synclinal was not observed. The Lower Silurian limestone was reached again on Stock creek, a tributary of Clinch, which within a mile of its mouth passes under a hill through a large tunnel excavated in the Trenton limestone.

This tunnel is properly regarded as a natural wonder. Its approaches are imposing, and the cliff of limestone, overhanging its mouth, is more than 450 feet high. A railway route was once surveyed through this tunnel, but the line was condemned as dangerous, since huge blocks of the limestone frequently fall from the overhanging cliff.

Drainage and Erosion.

Two forks of Powell river, Pigeon and Roaring, rise on the southern side of Black mountain and unite at the head of Big Stone gap, by which the resulting stream crosses the Stone Mountain fault. The South Fork of Powell river rises at the foot of Powell mountain near Little Stone gap; receives tributaries from the north side of that mountain as well as from the valley between it and Wallen's ridge; and, after crossing the fault of Poor valley ridge, by a shallow gap, joins the river at about a mile below Big Stone gap. Powell Mountain river flows between Stone mountain and Poor Valley ridge, for say fifteen miles, to opposite Pennington's gap, where it receives the North Fork. That stream rises on the slope of Black mountain and flows across the Stone Mountain fault by way of Pennington's gap. The main river, thus increased, flows southwardly for a little distance, and then crosses the fault of Poor Valley ridge.

The North Fork of Clinch river rises in the valley between Wallen's ridge and Powell mountain, and is separated by a low divide at its head from Wildcat creek, a tributary to the South Fork of Powell river. It flows along a monoclinal valley to the North Fork gap, which is sometimes known as Slemp's gap, where it turns toward the south-east. Within three or four miles, its course is again changed and the stream once more flows south-westwardly, following the foot of Powell mountain in a monoclinal valley.

Stock creek, another tributary to Clinch river, rises in Hunter valley, flows along the synclinal for several miles, then turns and flows up the dip to Clinch river. Clinch river itself rises far to the east of the region examined by me, and flows for a long distance near the line of the Stone Mountain fault, which it crosses and recrosses; but, at several miles east from the Little Stone gap, its course is changed, and the river for a while flows with the dip; but the course is again changed, and the direction becomes very nearly that of the strike.

It is sufficiently clear that the gaps through Stone mountain and Poor Valley ridge do not owe their origin to any convulsion of nature. The strike of the limestone and the conglomerate across Big Stone gap is perfectly true, and no evidence of a cross-fault or fracture is apparent there or in the coal-field behind the mountain. The absence of fracture is even more apparent in Pennington's gap through Stone mountain; for this gap is a tortuous passage-way with bold cliffs of the vertical conglomerate beds projecting from both sides. These cliffs afford ample evidence that erosion, not convulsion, produced the gap. The same condition is seen in the gap by which the South Fork of Powell crosses Wallen's ridge or the Poor Valley ridge fault. The North Fork gap in Powell mountain is as distinctly due to erosion as is the monoclinal valley along which the stream flows above the gap, or the tunnel by which Stock creek flows through a hill near Clinch river.

It may be stated positively that not one of the numerous gaps by which

streams cross the several faults and mountain ranges exhibits the faintest trace of any cross-fracture in the rocks.

At first glance, one might be inclined to suppose that the faults have influenced the direction of drainage. A deep valley has been excavated along the front of Stone mountain; another, digged out of the contorted limestone and shale of the Lower Silurian, follows the fault of Poor Valley ridge; the West Fork of Stone creek, a branch of Clinch river, has made for itself a broad valley near the Stone Mountain fault east from that of the South Fork of Powell river. These valleys arrest one's attention at once and they lie very near the lines of fault.

But valleys of equal importance are found where no fault exists to direct their course or extent. The monoclinal valley between Wallen's ridge and Powell mountain above the North Fork gap is as broad as the Turkey cove between Wallen's ridge and Poor Valley ridge; Wallen's valley, between Wallen's ridge and Powell mountain beyond the North Fork gap, is a monoclinal, and is one of the finest valleys in Southwest Virginia; the broad valley, followed by the North Fork of Clinch after it leaves the North Fork gap, is far removed from any line of faulting, and lies not far from the axis of the synclinal.

Erosion along the line of the Stone Mountain fault is interrupted, and the valley is far from being continuous; a well-marked divide separates the South Fork from Powell river and a bold divide separates the South Fork of Powell from the West Fork of Stone creek. The condition is similar to that in the valley between Wallen's ridge and Powell mountain; for a low divide intervenes between Wildcat creek and the North Fork of Clinch, while a high divide separates the latter stream from Wallen's creek, which flows along Wallen's valley.

The conditions in the immediate vicinity of the faulted lines appear to differ in no essential feature from those observed in less disturbed localities. It is evident:

First. That the course of the streams has not been determined by the lines of fault.

Secondly. That erosion along the faulted lines is essentially the same in character and extent with that in localities where no faults exist.

At the same time one may not ignore the fact that the faults have done much to hasten erosion along their lines as well as along the lines of streams belonging to the drainage system of Powell river, although one may be inclined to exaggerate the extent of this influence by forgetting that that drainage system is the important one in the region examined, while only a fragment of the Clinch river system falls within the area.

There must have been drainage before the faults existed. Evidently the rocks were more or less flexed previously; for the dips in Wallen's ridge and Powell mountain are almost due east, whereas those on the northerly side of the faults are north-west to north-north-west. It seems not wholly improbable that the faults are of later date than the disturbance which pro-

duced the comparatively gentle synclinal between Wallen's ridge and the Clinch river.

The faulting process was not abrupt; though a geologist might think it so, for to him a thousand years is literally as one day, and the whole of the historical period is insignificant. But this process of elevation, fracture and lateral displacement, required a vast length of time. The corrasive force of the streams must have deepened the channel-ways as rapidly as the rocks were raised. It is quite possible that the present system of drainage is as old as Carboniferous times, and that the disturbance producing the faults led to comparatively little change in its direction.

Stated Meeting, September 17, 1880.

Present, 4 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the Physical Society in Berlin, Jan. 2, 1880 (102, 103, XV, ii); Astronomical Society at Leipsig, Aug. 20 (104, 105); Association for National Science in Würtemburg, April 30 (102, 103, XV, i, ii); Agricultural and Historical Society at Lyons, March 10 (1 to 16, 18 to 20, 22, 24, 25, 27, 28, 32, 33, 35 to 62, 65 to 96, 98); Royal Academy, Amsterdam, Oct. 24, 1879 (102, 103); Massachusetts Historical Society, 30 Tremont Street, Boston, Aug. 12, 1880 (106, List); Public Library, New Bedford, Sep. 1 (106, List); Yale College, Aug. 26 (106, List); University of the City of New York, Sep. 1 (106, List); Astor Library, Sep. 13 (106, List); Regents of N. Y. University, Albany, Sep. 3 (106, List); N. Y. Historical Society, Aug. 23 (106, List); Penn. Historical Society, Sep. 7 (106, List); Maryland Historical Society, Sep. 6 (106, List); U. S. Coast Survey, Washington, D. C., Aug. 21 (106, List); Chicago Historical Society, Aug. 23 (106, List).

Letters of envoy were received from the Geological Survey of India dated Geological Survey Office, Calcutta, March 18, 1880, signed H. B. Medlicott, Supt.; L'Academie Royale des sciences, lettres et arts de Modene, dated July 31, 1880; Geologisch-botanische gesellschaft, Wien, I. Herren-

gasse, Landhaus; Königliche Sachsiche gesellschaft d. W. Leipsig, March 1, and April 27, 1880; Physicalische gesellschaft zu Berlin, Jan. 1, 1880; L'Academie royale des sciences à Amsterdam, Jan. 31, 1880; and Verein für Naturwissenschaft zu Braunschweig, Aug. 23, 1880. (All through the Smithsonian Institution.)

Donations for the Library were received from the Geological Survey of India [Vols. I to XVII of *Memoirs* (except I, i, II, ii, out of print); Series II to XIII of *Palæontologica Indica* (Ser. I and II, v, out of print); and Vols. I to XIII, i, of *Records*]; Geological Survey of Victoria; R. Society of Tasmania; Imperial Academy at St. Petersburg; Imperial Academy, Anthropological Society, and Geological Institute at Vienna; Imperial Academy, German Geological Society, Physical Society, and Zeitschrift f. d. ges. Nat. at Berlin; Royal Saxon Society, Observatory, and Zool. Anzeiger at Leipsig; Verein f. Nat. at Braunschweig; Verein f. V. Nat. at Stuttgart; Neues Lau. Mag. at Görlitz; M. Prof. Reneviers at Lausanne; Royal Academy of Lynxes at Rome; Société d'Agriculture, &c., and MM. A. Falsan and E. Chantre at Lyons; Anthropological Society, Museum of Natural History, Annales des Mines, and Revue Politique, at Paris; Linnean Society, and Com.-Geological Society, at Bordeaux; Royal Belgian Academy; Royal Academy at Amsterdam; Victoria Institute, R. Astronomical, Meteorological, R. Geographical, Geological, Zoölogical, R. Asiatic, and Society of Antiquaries, and London Nature; Geological Survey of Canada; Museum of Comparative Zoölogy, at Cambridge, Mass.; Professor Ed. Pickering; Prof. Asaph Hall; American Journal of Science, Prof. Jonathan Edwards, New Haven; Mercantile Library Ass. N. York; Franklin Institute, Journ. Pharmacy, Med. News, Dr. B. H. Rand, Philadelphia; Journal of Mathematics, Baltimore; Smithsonian Institution, Geographical Survey of the Territories, Chief of Engineers, Surgeon General's Office, and National Museum, at Washington; S. W. Burnham of Chicago; Missouri Historical Society; Geographical and Statistical

Society; Revista Scientifica; Ministerio de Fomento, and Meteorological Observatory of Mexico.

The following record was read from a letter from Mr. John Biddle, dated 1344 Pine Street, Sept. 8, 1880, for correcting the Society's List of Members.

James Biddle, eldest child of Wm. Biddle and Mary Scull, and brother of Edward Biddle (member of the first Colonial Congress); also of Nicholas Biddle (commander of the Colonial frigate "The Randolph"); also of Charles Biddle (member of the Supreme Court); was born Feb. 18, 1731; married Miss Frances Marks, June 30, 1753; died June 14, 1797. He was elected Prothonotary of the County of Philadelphia, Nov. 13, 1788, and appointed Judge C. P. for the County, Nov. 25, 1788.

The death of the Rev. Professor E. B. Andrews at Lancaster, Ohio, Aug. 21, 1880, in the 60th year of his age, was announced by the Secretary.

The death of Professor Samuel S. Haldeman, at Chicques, Lancaster county, Sep. 10, 1880, aged 68, was announced by the President, and on motion of Dr. LeConte, Dr. D. G. Brinton was appointed to prepare an obituary notice of the deceased. Dr. LeConte in making this motion said:

He was an accurate observer and a close student of nature during the earlier part of his life, which he gave to Zoology. Afterwards, when, by the failure of his eyesight, the minute inspection of specimens necessary to progress in any branch of Biology became no longer possible, he devoted himself to Linguistics and Archæology.

It may be here observed, that the correctness in observation and the logical accuracy in reasoning which in these days are the special characteristics of biological and physical research, and which he had acquired by his zoological studies, were in the change of pursuits of great benefit.

He carried into his new studies all the mental advantages which he had previously obtained from his varied investigations in Natural History. The relations of articulate sounds, the changes in sonance of words, their growth and complication by affixes and suffixes, were all studied in reference to the mechanism of the vocal organs, and the results educed were traced to the combination of those organs with the directing power of the brain, for the expression of intelligent language. But in regard to the minutiæ of his contributions to this branch of science, I know but little, and am not qualified to speak. I know only of his successes, with which all his friends sympathized, and of which the nation has reason to be proud.

In fine, he was an example of those rare individuals who, inspired by a true love of knowledge, pursue it according to their ability, without thinking of pecuniary reward or personal approbation. Such are the men who furnish the germs for future advancement in the realms of thought. Happy are those who are able to number them among their friends.

A communication was presented, entitled "Notes on the Cumberland or Potomac Coal Basin, by Howard Grant Jones, M. S."

Mr. Lesley drew attention to a remarkable feature of the section accompanying this paper, according to which both the Mountain limestone and the Mauch Chunk red shale formations are *duplicated*, and that upon a grand scale; the Upper red shale being 375 feet thick; the Upper limestone 301′ (followed by 70′ of gray shale); the Lower red shale 2000′; and the Lower limestone 475′ (underlaid by shale, flints and iron ore, 30+′); making the total apparent thickness of N, XI (counting in 200′ of green shales over the Upper red shale) between 3700′ and 3800′, a thickness even greater than at Pottsville in Schuylkill county, Pa. The duplication of the limestone formation in the column ought to have an important bearing upon the sub-division of the sub-carboniferous limestone group in the Western States. It may help to explain some of the prevailing confusion respecting the limestones exposed at apparently different horizons in Northern Pennsylvania.

Mr. Lesley proposed another Greco-Egyptian etymology, viz: *Ἰαχχος* from [Hor-m-] aχu, the Sphinx name of the Solar disc on the horizon.

He remarked that *Ἰαχχος* was the well-known Sun-god of the Eleusinian Mysteries, represented as suckled by Ceres; as Horus is frequently represented in the act of sucking the breast of Isis. The torch-flinging performance along the road from Athens to Eleusis represented no doubt the westward progress of the morning light.

Ceres was the mother of mystery, the darkness out of which the Sun is born, and the underground concealment out of which all vegetable life springs forth. Her name must be connected with the mystical celtic word *Cær*, the root of so large a mythical nomenclature; the equivalent of the full oriental form *Cabar* (or *Cabal*), and the key to the later Cabala. Hundreds of geographical names like Corinth, Carinthia, &c., embody it very plainly.

The destruction of *Ἰαχχος* by the Titans, as well as their destruction by Zeus, are myths explainable by the obstruction of the Sun's rays by mountains, and the victory of the Sun at the zenith. The part played by mountains in Solar mythology is shown by the ideograph of the name of the Sphinx, Hor-m-aχu; and is illustrated by the morning admiration of travelers on the Nile. It is much better to seek for the primitive ideas among the every-day phenomena of nature, than among the poetical and metaphysi-

cal inventions of later and more intellectual ages, when the victory of truth over error replaced that of day over night in the language of the initiated. We must come down to the classic age of the XIX dynasty before this spiritualizing process of the poets of the priesthood becomes well authenticated.

The connection of Ormuzd, Horus and the Shemitic *aur*, light, is evident; but the relationships of *lux*, *fax*, and *ox* (oculus, *ωψ*) and of *lux* with *ῥειν*, *ruere*, and of *fax* with *Ιαχχος* will also repay an effort at development.

The President reported that he had received a letter from Drexel, Harjes & Co., of Paris, advising that the sheet allowed for the receipts of interest on the 3 per cent. French Rentes, belonging to the Michaux Legacy had been filled up. The rules of the French Treasury require that a new sheet and inscription shall be made in the name of the Society. They forwarded the proper petition to the Minister of Finance for that purpose which has been duly signed by the President and Treasurer in the presence of the French Vice-Consul at Philadelphia, and the same duly and officially certified by him as required by the laws of France, and such petition has been sent to Messrs. Drexel, Harjes & Co., at Paris.

And the meeting was adjourned.

Notes on the Cumberland or Potomac Coal Basin. By Howard Grant Jones, M. S.

(*Read before the American Philosophical Society, September* 17, 1880.)

This field is a long triangular territory of about sixty miles in length, lying along the outside or eastern edge of the great Alleghany uplift, and is situated in Somerset county of Pennsylvania, Alleghany county, Maryland, and Mineral county, West Virginia. Although considered a spur, the basin is rather an overlapping of the Coal strata to the eastward of the Alleghanian fold which demarcates the celebrated Coal fields of those States. It is with Broad Top and an unexplored basin in Alleghany county (New River) the only deposits beyond this line. On leaving Pennsylvania this persistent anticlinal becomes "Savage Mountains," which bend south west towards a geological center at Union, in Maryland, where are pinned together the southern extremities of the several basins of Maryland and Pennsylvania lying parallel to the Alleghanies. The Coal strata here flow over Savage mountain into the Potomac basin, virtually terminating this range in the general elevation. The name and bold characteristics of

the Alleghanies are here, however, taken up by a range of mountain fifteen miles to the eastward, forming the border of the field (Davis mountain of Maryland, and Front ridge of Virginia). Union is a point situated on the great swell or uplift in northern West Virginia pointed out by Professor Rogers.

The rocks of Savage mountain are composed of the Mauch Chunk Red Shales and Limestones (XI) and the overlying Conglomerate (XII). They fold under the field with a dip of from 10′ to 20′, and rise up again in Davis mountain, five miles beyond, with a reverse dip considerably strengthened. There is a line of upthrow lying east of the basin, running along the outlying red shale valley, composed of the lower limestones, the flint and the hard sandstones of X and IX (Pocono and Catskill).

Wells' Creek mountain at the northern end of the basin, is flanked by the uplifted Pocono sandstone and crowned by the same, as it returns and dips down the east flank, on its way under the town of Cumberland. It carries here on its back the overlying slates and flints, iron ore and lime strata of XI. A range of little mounds dotted along between the basin and this mountain range shows the harder limestones on edge. In Wells' Pass, under the curve or anticlinal of the Pocono sandstone, is to be seen the red sandstone of IX, though quickly returning.

Knobby range, further to the south, towards Piedmont, probably carries the Great White Sand (X), since at Keyser we find the lower limestones of the red shales and the underlying flints upturning east of the town and the New Creek ridge, and just west of the range. The Mauch Chunk shales (XI) show on the Potomac, near Keyser, dipping 45° to the northwest.

The accompanying section has been made at different points on George's creek, from Barton to Piedmont and on Potomac to Keyser. It includes the Coal Measures, from a seam 400 feet below the Pittsburg Coal; possibly the Conglomerate Series; the duplicate beds of red shale and limestones to the Great White or Pocono sandstone. The intervein strata to the Great Bed has already been published in Tyson Section, Plate VI, Report HHH.* The Lower Barren group of coals are here distinctly shown with their fossil limestones and sandstones, down to the Mahoning SS. Founded on the existence of the underlying Ferrfferous limestone at Stony river, Prof. J. P. Lesley some time ago identified the Upper Bloomington or six feet coal of this basin as the lower Kittaning seam. This is now proved by the discovery of the fire-clay and limestones on the Baltimore and Ohio R. R., and the lower iron and clay deposits to the Piedmont SS.

The unveiling of the Conglomerate series of sandstones is important, showing a total thickness of 560 feet, from the Piedmont sandstone down to the lowest bed of coal. This series has its coal deposits through its entire thickness, though not largely developed. But at least one workable large seam has been noted, but has been omitted because of the uncertainty of its proper position.

* Report of Progress of Second Geological Survey of Pennsylvania, Somerset county, by F. & W. C. Platt.

The existence of a green shale and sandstone deposit of 200 feet, underlying the Conglomerate series and carrying an undeniable print of its relation to the Mauch Chunk shale in the red-hued earth topping it.

The most noticeable feature is the doubling of the red shale and limestone deposit of XI. There are two distinct series, under no condition possibly to be confounded or misidentified. The upper of 375 feet, red shale and black (fossil), red and gray limestone of 200 feet underlying; the lower of 2000 feet red strata and 450 feet gray limestone. Both series being fossiliferous in the upper part.

Another feature is the shale, flint and iron ore deposit, 300 feet, underlying the foregoing groups and separated from the red rocks of IX by the only heavy sandstone (Pocono SS.) at this horizon. It is a pure, hard, solid white rock.

Section of strata from Lower Barren Measure to Pocono Sandstone, as found on George's Creek and the Potomac River, Western Maryland and Virginia, June, 1880.

24′ Sandstone. See base of Prof. Tyson's Section, Plate VI, Report H. H. H., Second Geological Survey, Penna. The strata from this sandstone to the Pittsburg seam and higher are there given.

39′ Shale. Lower three feet contains Neuropteris, Calamites, Pecopteris.

6″ Slate Bland fine gr., containing Neuropteris angustifolia, Loschii and tenuifolia.

3′ 3″ *Coal. Hampshire Seam.*, probably same as Coleman bed of Somerset Co., Pa. It is 3′ 3″ at Barton, 4′ 10″ near Piedmont, 5′ on Savage river near Bloomington, 3′ 10″ on Sharpless Hill, ten miles to the southward. It is probably the "Rock Coal" of Millersburg, Pa. It is characterized by bottom slate, shale roof, salmon-colored ash from lower bed, and ferns. It is the most widely known bed in the basin except the Six foot (Kitt.). It is 388 feet below Pittsburg seam, Barton; 4′ 10″ at Moore's run, 347 feet Hampshire Co., Virginia, workings near Piedmont. It runs from 2.5% ash at bottom to 15% ash at top of bed; and sulphur in same relations from .57% to 1.75%.

10′ Fire-clay containing more or less balls of iron. Blue color.

6′ Limestone.

15′ Sandstone.

12′ Shale.

10′ Sandstone.

3′ 2″ *Coal. Bartlett's Run seam.*

10′ Black slate.

6′ Shale.

4′ 9″ Fire-clay. Impure.

9′ 9″ Sandstone.

9′ Gray shale.

6′ 2″ Marius shale. One foot fossiliferous limestone at top.

4″ *Coal.*

5′ 5″ Sandstone.
5′ 2″ Shale.
1′ 6″ *Coal.*
1′ 4″ Shale.
5′ Fire-clay.
5′ " sandy.
50′ *Sandstone pebbled. Mahoning S. S.?* Not identified north of Frostburg. At Barton and below it is a hard, fine-grain half-bedded pebbled rock of 40 feet. At Crooked run, 12 miles south of Piedmont, it is fully pebbled. On Stony river, further south yet, it is simply a mass of agglutinated pebbles of 60 feet.
5′ Shale.
1′ 10″ *Coal.*
20′ Shale, with limestone at bottom.
6′ Shale.
4′ Sandstone.
4′ Iron ore, clayey.
5′ Fire-clay. Free from balls of iron and plastic.
5′ *Coal.* Bear's Hollow Coal, Morrison's seam. Near Barton it is 3′ 4″. At Bloomington it is 5′, at Piedmont 5′ 6″, and at Sharpless' Hill 5′ 2″, and further south much thicker. It is characterized by hard nature of the coal and its fire-clay roof and floor. Contains little pyrites and yields 5% of ash, gray. It runs about 40′ under the Mahoning pebble rock above and 175′ over the Upper Bloomington seam (Kittan.). It runs 200′ to 220′ under the Hampshire Coal, at the head of section.
10′ Fire-clay.
10′ Sandstone.
20′ Shales.
2′ 8″ *Coal.*
2′ Clay.
15′ Sandy shale.
1′ *Coal.*
10′ Fire-clay and shale. Fire-clay and shale containing iron ore in center of bed.
10′* Hard sandstone. Reddish color.
10′ Black slate.
3′ Sandstone.
30′ Shale. Containing marine shells and a reputed coal.
40′ Sandstone.
10′ Shale and black slate.
5′ 6″ *Coal.* Upper Bloomington seam. Kittanning Lower Coal. It is probably the "Savage" seam of Millersburg. At Piedmont it is 5′ 6″; at Bloomington, 5′; McCorbin's hill, 7′ 2″; Rinker's hill, 8′ 3″; at Falls Stony river, 9′. Characterized north of Piedmont by middle slate, calamite tufts in roof overlying sandstone and fire-clay flow. In

lower part of basin by heavy top slate and the unusual size of seam, as above. It is a bright, soft coal, yielding 7% gray ash and somewhat sulphury. It runs from 70 to 90 feet over the Piedmont sandstone, and 750 to 800 feet under the Pittsburg seam.

10′ Clay and ore.
2′ Sandstone.
8′ Limestone.
12′ Sandstone.
4′ 10″ *Coal.*
5′ Clay.
4′ Shale.
1′ Iron ore.
7′ Shale, clay and sandstone.
5′ Clay, pure. Fine clay bed. It is probably much thicker than this within the mountains, and resembles in appearance and quality the Mt. Savage clay bed. (See below.)
22′ Sandstone. Sometimes found pebbled, as if indicating the approach to the conglomerates.
1′ 8″ *Coal.*
10′ Fire-clay.
30′ *Sandstone. Piedmont Sandstone.*
4″ *Coal.*
41′ Sandstone and shale.
11′ Sandstone pebbled.
2′ 6″ *Coal.*
12′ Shale.
38′ Sandstone.
2′ 6″ *Coal.*
53′ Unknown, shaly.
38′ Sandstone.
42′ Shale.
1′ 10″ *Coal.*
5′ Shale.
43′ Quartz sandstone.
1′ to 4′ *Coal.*
8′ Clay. Mt. Savage. It is a pure shale clay of great standing power. It thickens to 16 feet at places, and lies in rolls or pockets in a softer and semi-plastic clay lying under it. It contains but little iron or potash. It has been opened at Williams station, Somerset Co., Pa., and at Ellerslie, Pa., also near Mt. Savage, and is found cropping along the crest of the mountain on each rim of basin.
4″ Slate.
6″ *Coal.*
60′* Sandstone conglomerate, with vertical split.
15′ Shale.
55′ Sandstone.
6″ *Coal.*

22′ Shale interval.
35′ Sandstone.
20′ Thin shaly sandstone.
1′* *Coal.*
5′ Black slate.
20′ Sandstone.
1′* Lowest *coal.*
14′ Shale.
10′ Red bluish shale.
75′ Shale.
40′ Sandstone, hard.
50′ Green shale.
10′ Sandstone.
375′ Red shale.
40′ Fossil *limestone.*
28′ Green shale to reddish.
3′ Red *limestone.*
4′ Red sandstone.
36′ Red *limestone.* Not fossiliferous.
160′ Impure and interstratified *limestones* and sandstones.

} *Upper Limestone* of the Mauch Chunk shale, same as found in Youghioghany valley, called "*Sang Kine* limestone."

30′ Gray, wavy *limestone*, showing washings or waves of color in structure.
20′ Undetermined.
50′ Sandstone.
2000′ Red shales.
440′ Limestone strata, fossiliferous at top; 40 feet pure cement limestones at bottom.
300′ Brown shale and flints, containing *iron ore beds at base.*
80′ to 100′ Pocono sandstone.

Résumé.

Lower Barren and Sub Lower Coal Measures		563 ft.
Conglomerate Measures	XII	560 "
Green Shale and Sandstone		200 "
Red Shale (Upper)		375 "
Limestone (Upper)		301 "
Gray Strata	XI	70 "
Red Shale (Lower)		2000 "
Limestone (Lower)		475 "
Shale Flints and Iron ore		300 "
Pocono Sandstone	X	100 "
		4944 ft.

Stated Meeting, October 1, 1880.

Present, 6 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was received from Prof. Ira Remsen, dated Baltimore, September, 24.

Letters of acknowledgment were received from the Philosophical Society, Glasgow, Sept. 11 (105); Museum of Comparative Zoölogy, Cambridge (106); and Mr. J. H. Crane Coffin, Sept. 18, 1880, Washington, D. C. (106)

A letter of envoy was received from the Royal Observatory, Greenwich, dated Sept. 1, 1880.

Donations for the Library were received from the Royal Academies at Berlin and Brussels; the Zoölogischer Anzeiger; Royal Venetian Institute; Revue Politique; London Nature; Prof. Richard Owen; Free Public Library, New Bedford; American Chemical Society; Prof. E. D. Cope; U. S. Bureau of Education, and the Kansas Historical Society.

The Secretary reported that Dr. Brinton accepted the appointment to prepare an obituary notice of Prof. S. S. Haldeman.

Mr. Fraley reported that the address in memory of the late President, George B. Wood, M.D., LL.D., prepared at the request of the Society, by Dr. Henry Hartshorne, would be delivered in the Hall of the College of Physicians, on Monday evening, Oct. 11, at 8 o'clock.

Pending nominations, Nos. 904, 909 to 919, and new nomination, No. 920 were read, and the meeting was adjourned.

Special Meeting, October 11, 1880.

(In the Hall of the College of Physicians.)

President, Mr. FRALEY, in the Chair.

After an introduction by the President, Dr. Hartshorne addressed the members and invited guests of the College of

Physicians, the Trustees and Faculties of the University of Pennsylvania, Jefferson Medical College, and Woman's Medical College of Philadelphia, and the Managers of the Pennsylvania Hospital, and Philadelphia Dispensary, as follows:

Memoir of George B. Wood, M.D., LL.D.,

By Henry Hartshorne, A.M., M.D.

(*Read before the American Philosophical Society, October* 11, 1880.)

With a long life, not much varied in events, nor brilliant in deeds that meet the public eye, Dr. George B. Wood may be named as one who, in the main features, and, indeed, in almost every particular of his career, has left an example worthy of admiration and emulation. It will be acknowledged by the least enthusiastic of his friends and associates, that he was one of the most useful men of his generation.

He was born at Greenwich, in New Jersey, in the year 1797. His own memoranda of his ancestry are not devoid of historical interest in connection with the early settlement of this city, as well as that of our neighboring State. It appears that Richard Wood, a member of the Society of Friends, came to this country with William Penn in 1682, bringing with him his son James, and settled in the northern part of the then new city of Philadelphia; where Wood street probably received its name from him. There is reason to believe that while James Wood remained in the city, another younger son or sons of Richard Wood went to New Jersey, locating themselves in Salem and

Gloucester counties; Woodstown and Woodbury being, in all probability, named after them.

Farther back, in Gloucester, England, traces have been found of the family annals, through the Woods of Brockrup in the 16th, and of Gobril in the 15th century, to a still earlier period, when their predecessors inhabited for many successive years the ancient Court-House of Gloucester; now, long since, converted into a farm. Late in Dr. Wood's life, he was informed of the decease of a very wealthy banker, named James Wood, in Gloucester, England, without direct heirs. Legal gentlemen called upon Dr. Wood, proposing to dispute this banker's will, in his favor, as a collateral heir; the property having been left to an alderman named Wood, in London. While declining this proposition, Dr. Wood remarked upon it as follows: "Had the existence of such relations been known to Mr. Wood, and especially had accident brought us into close intimacy or association, it is not improbable that he might have preferred persons of his own blood as the heirs of his fortune, to one whose only claim upon him was the name of Wood, and a few flattering attentions."

Two sons of James Wood of Philadelphia, above mentioned, early in the 18th century left this city to settle in Southern New Jersey; probably under the auspices of Thomas Chalkley, a prominent member and preacher of the Society of Friends; who contemplated founding, upon the banks of the Cohansey river,

a great city which might rival Philadelphia. Before that time, as early as 1683, the same design had been formed by John Fenwick, who became Proprietor of West New Jersey by conveyance from Lord Berkeley, successor to the Duke of York, afterwards James II., who was grantee of the Crown. Fenwick left a will, directing a city to be erected near the Cohansey, which he willed thereafter to be called Cæsarian river. All that followed this large project, however, has been the growth of the small town or agricultural village of Greenwich.

Dr. Wood kept in his possession a deed, signed by the agent of William Penn, who acted as executor of John Fenwick, conveying a lot of ground forming a part of his Greenwich farm.

In each generation, the heads of this family in New Jersey have been men of consideration and local distinction. Richard Wood, the father of the subject of this memoir, was a man of superior mind and strong character, much respected by all who knew him. He was described by an acquaintance, speaking of him to Dr. Wood, as "a prince of a man." He married twice. His second wife, mother of George Bacon Wood, was Elizabeth Bacon, of Bacon's Neck, New Jersey. Of the early settlement of her family in that part of the country, evidence is preserved. One or two memoranda may be here interesting: "1683, June 25th, Shank-a-num and Et-hoe, Indians, convey to John Nichols, of Nichols' Hartford, near Cohansey, 100 acres of land,

part of the tract known to the Indians as Cat-a-nungut, adjoining lands of Samuel Bacon and others."

"1685, August 12th, John Nichols and wife convey 100 acres of land to John Bacon of Cohansey."

George B. Wood was the eldest son of Richard and Elizabeth Bacon Wood. At twelve years of age, his earnest desire for a liberal education was gratified by his father sending him to school in New York. When sufficiently prepared, he was transferred to the University of Pennsylvania, where he was graduated, with honors, in 1815.

Of his early life I have obtained but little particular account, beyond what is preserved in his own manuscripts. These show a very active mind, more alive with imagination and sentiment than would have been supposed by those acquainted only with his later labors. He wrote, between 1813 and 1825, many verses, mostly in English, some in Latin; amongst the former, several translations from the German of Schiller. With the German language, as well as the French and Italian, he acquired considerable familiarity; which was of use not only in his later arduous professional studies, but also in his very diversified general reading, and European travel. His library contained many books in foreign languages. It may surprise some who have known him as a most industrious student, and the author of ponderous medical works, to learn that he read quite a large number of novels; especially during his summer vacations. More remarkable

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still, he planned, and wrote the greater part of a novel of his own; which I have seen in manuscript. It was never published.

Amongst the papers above referred to there is, under the date of 1814, "An Oration spoken before the Citizens of Philadelphia, on the Independence of the United States." This was delivered a year before his graduation at the University. In the year 1817, he contributed to Poulson's American Daily Advertiser a very spirited reply to an aspersion upon the Society of Friends, charging its members with a want of charity outside of their own borders, which had been published in the Portfolio of that day. The editor of the latter periodical replied, withdrawing, or essentially modifying, his injurious expressions.

Upon leaving the Collegiate Department of the University, young Wood began the study of Medicine as the office student of Dr. Joseph Parrish. His advantages there were decidedly superior; and he availed himself of them so well as to become, after his graduation in Medicine at the University in 1818, his preceptor's associate in giving instruction to students. A private medical school grew out of this association; in which a number of our most eminent physicians and surgeons, of the generation now passing away, took part, first as pupils, and some of them afterwards as instructors. Under such circumstances, Dr. Wood matured those convictions upon practical medicine and medical ethics which he inculcated through his whole

life; and which, during the forty-two years of his continuous labors as a medical professor and clinical teacher, were spread broadcast throughout this country. No one man has ever done so much as he, to form and influence medical opinion in America upon both practical and ethical questions. Well has it been for the profession, that his teaching was dictated by good judgment, careful study, and, above all, the highest principles of rectitude and honor.

Dr. Wood's first course of lectures was one upon chemistry, delivered to a non-professional audience, chiefly composed of ladies, in Dr. Joseph Parrish's private office. Here, in a lay course, as Dr. Littell observes, in a Memoir* to which I am much indebted for information, "before a class entranced by his carefully prepared experiments and not likely to be hypercritical in its judgments, he gained confidence and dexterity, and was thereby better fitted to perform his part in a more formal and important sphere." There was a tradition amongst medical students and others, that Dr. Wood was not, at the beginning of his work as a teacher, an easy, fluent or graceful speaker. It is entirely accordant with what we know of his whole life, to suppose that this may have been true; and that his having become, in maturity, one of the most admirable and successful lecturers of his time was due far less to any natural gift of eloquence than to assiduous and long continued exercise and cultivation of his powers.

*Read before the College of Physicians of Philadelphia, October 1, 1879.

Shortly after the Philadelphia College of Pharmacy was founded, in 1821, Dr. Wood was invited to become its Professor of Chemistry. He accepted the position, and held it, with success and popularity, from 1822 to 1831, when he was transferred to the Chair of Materia Medica in the same institution.

In 1835, when the Chair of Materia Medica in the University of Pennsylvania (before held by Dr. John Redman Coxe) became vacant, Dr. Wood was elected to occupy it. I have had before me a letter addressed by him, during the canvass, to James S. Smith, one of the Trustees of the University, at the request of the latter, in which, with modesty and yet with distinctness, he sets forth some of the reasons, growing out of his abundant preparation, for his claim of eligibility to the chair. He mentions in this letter the fact, that during the year 1829 he devoted all his leisure for nine months, in conjunction with Drs. Hewson and Bache, acting as a Committee of the College of Physicians, to the revisal of the Pharmacopœia of the United States. So many alterations were found to be required, that it was necessary to rewrite almost the whole work. Before the Committee was satisfied, Dr. Wood states that he had written all of the manuscript copy at least twice over with his own hand. Through its subsequent adoption by a National Convention at Washington in 1830, this Pharmacopœia became the standard authority for the preparation of officinal medicines throughout the United States; and it

has so continued, with repeated revisals, down to the present time. Not long after completing this important work, Professor Wood began, with Professor Franklin Bache, aided for a time by Daniel B. Smith, then President of the Philadelphia College of Pharmacy, a very elaborate commentary upon the Pharmacopœia, under the name of the United States Dispensatory. This, which made a volume of more than a thousand large and closely printed pages, was begun and finished by its authors in less than two years. It has, since that time, passed through fourteen large editions; the aggregate number of copies sold, during Dr. Wood's life-time, amounting to 120,000 copies; as it has long been regarded as everywhere indispensable to both the medical and the pharmaceutical professions. The intimate association of Doctors Wood and Bache, in the preparation of this most useful work of reference, was only a part of the fabric of their life-long fraternal friendship. This close intimacy was the more remarkable on account of their being opposed in interest as professors in the two great rival medical schools; that of the Medical Department of the University of Pennsylvania, and the Jefferson Medical College of Philadelphia.

In the professorship of Materia Medica and Therapeutics in the University of Pennsylvania, Dr. Wood reached the culmination of his reputation as a public Teacher. He was one of the leaders in that great reform in instruction upon scientific subjects, which

has now become universal; in which illustration and demonstration, by the constant presentation of objects to the sight, are prominent and essential. His courses of lectures upon Materia Medica may be truly said to have been splendid, almost magnificent; adorned as well as made complete for the students' information, by the exhibition, from day to day, of living specimens of medicinal plants from all quarters of the world, grown in his own private conservatory and botanical garden, maintained for this special purpose. When such could not at the time be obtained, fine pictorial representations were placed before the class in their stead; and his cabinet of mineral and other crude and prepared specimens was correspondingly complete. A printed syllabus of the course of lectures, interleaved for note-taking, was furnished gratuitously by him to each student. It may be said, indeed, that no portion of the curriculum of the Medical Department of the University, able and renowned as have been the other members or its Faculty, ever added more to the great reputation and large classes of that institution, than this model course. Dr. Wood continued to hold the Chair of Materia Medica and Therapeutics until 1850, when he was transferred to that of the Theory and Practice of Medicine, upon the retirement from the latter of Professor Nathaniel Chapman. This chair he retained until 1860, when he withdrew from all active professional labors.

Among other literary contributions of the earlier

portion of Dr. Wood's professional life, one not without importance was, his taking prominent part in the editorship of the North American Medical and Surgical Journal. This quarterly periodical attained the highest standing, being conducted by a number of gentlemen of ability and learning; although it gave way, after a few years, to a successor in the same field, under circumstances more favorable to a permanent existence.

In 1835, Professor Wood was appointed one of the attending physicians to the Pennsylvania Hospital. The duties of this responsible post he performed, with unremitting faithfulness, until the year 1859. His clinical lectures in that institution, to numerous classes of medical students, were admirable. Great improvements in the methods of ascertaining conditions of internal disease, and especially in the physical diagnosis of affections of the lungs and heart, were brought hither from Europe after Dr. Wood had begun his career as a medical teacher. Having no ultra-conservatism in regard to novelties, he applied himself to the practical study of auscultation and percussion; so as to become proficient in their bedside use. Not content, however, with his own skill in these newer methods, he availed himself, not unfrequently, of the assistance of the late Dr. W. W. Gerhard, with whom they were a specialty, in the diagnosis of cases under his care in the Hospital. It was one of Dr. Wood's characteristics, that, in his earnest and conscientious so-

licitude for the interests of his patients and pupils, he was always ready to supplement and extend the advantages of his own personal instruction, by engaging, upon the most liberal terms, the services of others in particular departments. This was constantly done by him in regard to his own private students, of whom, until about the year 1855, he always had a large class. Several of our most distinguished physicians, now leading practitioners and professors, can look back with grateful reminiscences to the hours advantageously spent, in review of their University studies, as Professor Wood's office pupils.

No event in Dr. Wood's life was of more cardinal importance to him than his marriage; which took place in 1823, to Caroline, only daughter of Peter Hahn, a wealthy merchant of Philadelphia. Congenial, domestic in her tastes, and devoted in her attachment to him, she was able, also, by her receipt of large means from her father, to secure her husband in an independent position in the world. Some men would have availed themselves of this, to withdraw from care and toil of every kind, and to enjoy their leisure in travel and in social or literary recreation. Not so with Dr. Wood; while generous, and sometimes even stately, in his mode of living, he employed the resources placed within his reach mainly in enlarging and improving his processes of instruction; into which, as well as into the composition of his books, he threw all the energy of his nature. It was a familiar fact to his contemporaries in

the medical profession, that the neediest practitioner, lecturer or author among them all, seldom worked so hard, and so incessantly, as Dr. Wood. The motives which sustained him in these laborious habits, were, evidently, not at all a desire to accumulate farther wealth, but a love for his pursuits, *per se;* a very earnest purpose of usefulness to his fellow-men; and, it may be, a not ignoble valuation of his own reputation.

Although without offspring, the companionship of his excellent wife was to him a constant source of happiness, until her death in 1865. With this loss, following that of Dr. Bache in 1864, began the decline of Dr. Wood's vigor, which slowly, and almost insensibly, proceeded, until his decease in the Spring of 1879.

In 1847, before his transfer to the Professorship of Practice of Medicine in the University, he published his great treatise, in two volumes, on the Practice of Medicine. This was at once recognized, at home and abroad, as an authoritative work. It became a favorite text-book for students, not only in this country, but also in Great Britain. The time-honored University of Edinburgh was one of several foreign medical schools in which it was officially approved and adopted. It passed, during its author's life, through six editions.

This work was followed, in 1856, by another, also in two octavo volumes, a treatise upon Therapeutics and Pharmacology. Of this, three editions were issued; the last in 1868. In both of these works, Dr. Wood showed the most indefatigable industry and excellent

judgment, in research, selection and arrangement, of all the knowledge obtainable upon his subjects. In neither is there manifested much originality of invention, discovery or suggestion. Exception may, however, be made to some extent upon this last point, so far as to say that he always exhibited great readiness, and sometimes ingenuity, in accounting for things which, to many others, seemed difficult to explain. I never knew him to be without a probable hypothesis, when one was wanted for such a purpose, whether in pathology or therapeutics, or in social or political affairs.

Dr. Wood's mental outlook was, indeed, far from being narrow, or in any sense restricted to matters connected with his own profession. He was earnestly and actively interested, for several years, in the establishment of Girard College according to the designs of its endowment. There is amongst his papers, in connection with this, a communication to the *Philadelphia Courier and Enquirer* of the date of Monday, Dec. 28, 1840, a really eloquent appeal to the citizens of Philadelphia, signed "Girard;" in which the philanthropist is personated as calling from his grave upon those to whom his trust had been confided, to end their long delay in the fulfilment of his cherished purposes for the benefit of the orphans of the City and State of his adoption. A few words from this paper may be here not inappropriately cited, as an example of its author's style.

"I entreat you," he writes, "by our former fellow-

ship and by all the good which I have intended for you and your children, I require of you by the obligation of an accepted trust, I conjure you by the terrors of a wounded conscience and a retributive judgment, to guard faithfully the sacred pledge which I have deposited with you. Should any one attempt to violate its sanctity, and abuse it for some unholy purpose, let him feel the weight of your indignant reproof. Should a public servant dare to propose a dishonorable application of it to your own wants or necessities, frown him into that contempt which every pander merits. If injury has accrued from former neglect, do all that you can to remedy the past and to guard the future."

In presenting this appeal to the public, after nine years had elapsed without any application of Stephen Girard's legacy to the education of orphans, it was understood that its author represented, although informally, the wishes of the Trustees of the College.

Shortly afterwards, Dr. Wood, as chairman of a committee of the same Board of Trustees, prepared a formal communication to the Select and Common Councils of Philadelphia, urging immediate action to carry out the provisions of Girard's will, by legal enactments and appropriations. The result of this conflict, however, between the Councils and the Board, was the dissolution of the latter, of which Nicholas Biddle was then President; and, also, the termination of the official connection with the College of its first President, Alexander Dallas Bache.

An important contribution was made, also, by Dr. Wood, to the organization of Girard College, in the form of a report of a committee of which he was chairman, upon the clothing, diet, etc., of its orphan pupils. This report comprised a brief but clear and systematic statement of the principles essential to the healthy conduct of such an establishment; such as, if carried out, must have secured to it from the start, excellent sanitary conditions.

Among other subjects upon which Dr. Wood wrote well, as he did upon all topics which interested him at all, was that of the Temperance reform. He contributed to the *United States Review*, in January, 1834, an article about fifty pages in length, on the "Temperance Cause." His views, in this article, were *advanced* for that day, although confined to an exposition of the evils attending the use of ardent spirits as a drink, and of immoderate indulgence in the use of fermented beverages. That, with longer reflection and experience, his mind did not greatly change upon this subject, was shown by a note appended by him to a reprint of the above mentioned article, in 1872. "Were our efforts confined," he there says, "to the exclusion of ardent spirit or distilled liquors from use, there might be some hope of success in the end; as a people among whom temperance could be established, with this limitation, could never, so long as the rule continued, become a nation of drunkards."

It may be remarked that Dr. Wood's retired position

in his later life may have debarred him from a close acquaintance with that pressure of facts in regard to the effects of intemperance in our own and other countries, which, with the evidence that the limitation which he urged cannot be anywhere extensively carried out, has brought many cautious minds in our time to conclude, that, to control what seems, next to war, the chief destroyer of modern nations, no prohibition, no personal or general sacrifice can be too great. It may be proper to say here, also, that, in his own way of life, Dr. Wood, while very fond of hospitality, and making his house a favorite social centre, especially for the members of his own profession, was a marked instance of the benefits of that temperance which he so ably defended and enjoined.

Historical composition always had a great attraction for Dr. Wood. In the two volumes of his Memoirs, Lectures and Addresses, published, the one in 1859, and the other in 1872, we find the following papers expressly of that character:

History of Materia Medica; History of Materia Medica in the United States; Sketch of the History of the Medical Department of the University of Pennsylvania; History of the Pennsylvania Hospital, delivered at the centennial celebration of its foundation, with a supplement to this, delivered at the laying, in 1856, of the corner-stone of the new Penna. Hospital for the Insane; and a *History of Christianity in India.*

The last named of these historical memoirs was part

of a larger plan of a *History of India*, conceived by its author in early life, and abandoned on account of the demands made upon his time by his professional duties. The eleven chapters which were completed make more than a hundred pages of the volume of Memoirs, &c., published by him in 1872. There is added, also, as a supplement, an Address on the British East India Empire, which was delivered by Professor Wood before the Athenian Institute of Philadelphia, January 23d, 1839. From the latter, we may take, as bearing upon a topic whose interest to the world at large is increasing every year, the following concluding reflections:

"But," it is there written, "the fortunes of India and Great Britain are not to be forever united. The English themselves, even those who have labored most assiduously in the consolidation of the Indian Empire, look forward to an ultimate separation. They look forward to the time, when, through the agency of causes brought to bear upon the people of India by their present political relations, they will have become enlightened, refined, elevated in sentiment and conduct; when the adoption of a pure religion will have cleansed away the moral foulness which now corrupts every spring of action; when their long union under one common government will have given them a feeling of political identity, a spirit of nationality and patriotism, which may lead them to desire independence, for which their expanded intelligence and purer morality shall have fitted them. When thus ripe for self-government,

may we not reasonably hope, that India will fall off spontaneously and peaceably from her long attachment, and, either as one or as several people, take her place in that brotherhood of nations, which, in America, in Africa, and in Australasia, will have owed their origin or civilization directly or indirectly to Great Britain, and will continue to revere the name and cherish the institutions of this mother of empires, when she herself shall have fallen into the decrepitude of age, or have gone to join her predecessors in the realms of history?"

A number of Biographical Memoirs, also, were written by Dr. Wood. We find, in his first volume, a memoir of Dr. Joseph Parrish, and one of Dr. Samuel George Morton; in the second volume, of Dr. Franklin Bache, of Frederick Beasley, D.D., and of Dr. James L. Fisher. All but one of these were prepared either for the American Philosophical Society, or for the College of Physicians, or the Medical Society of Philadelphia.

Of scientific contributions by Dr. Wood to the Proceedings of the American Philosophical Society, I find record of four. The first of these was delivered as an address to the Society, in 1860, his second year of service as its President, upon "Dangers of Hasty Generalization in Science." It exemplified, as well as inculcated, that cautious, although never timid spirit, which becomes the true philosopher; which welcomes the appearance of every promising novelty,

in science or in art, but always refuses to accept it simply because it is new; which believes everything which is proven by sufficient evidence, but nothing without evidence, whatever its attraction to the fancy, the intellect, or even the moral sense.

Dr. Wood's other papers, published in the Proceedings of this Society, were upon the subject of his observations and experiments, carried on through several years, upon his farm at Greenwich, in regard to the fertilizing and renewing action of the alkali potassa on the growth of fruit-trees, potatoes, wheat and other plants. The addition of wood ashes empirically to certain soils under cultivation, has long been a common practice in many places. By the chemical analysis of plants and of the earth in which they grow, as Dr. Wood mentions, their mutual physiological relations have, especially since the investigations of Liebig, been generally understood. But the merit of Dr. Wood's observations is, that they have furnished means of definite experimental demonstration, upon a considerable scale, of the practical application of this part of the chemical physiology of plants, in a manner productive of direct agricultural and horticultural profit.

Every inquiry of such a kind is, of course, of a complex nature, and the inferences derived from it must be properly collated and correlated with other facts and laws, which may qualify both their interpretation and their application. But the scientific and practical value of such investigations is beyond doubt; espe-

cially when carried on with the patience, carefulness and candor which attended those which have been thus briefly recorded.

Dr. Wood's professional eminence and personal qualifications led, naturally and suitably, to his being called to high official positions. In 1848, he was elected President of the College of Physicians of Philadelphia; an office which remained with him thereafter until his death. In 1855, he was made President of the American Medical Association; and in 1859, President of the American Philosophical Society. In this last position, he followed, after an interval of some years, Dr. Nathaniel Chapman. Both of these appointments may be regarded as not only altogether appropriate on account of the high individual merits of those who received them, but, also, as evincing a recognition of the relation of the medical profession to the general advancement of science, to which medical men here, as elsewhere, have rendered such large and numerous contributions; besides exemplifying, in their own vocation, the principle that science lives and works most fitly, not for its own intellectual aims alone, but also for the common benefit of humanity.

In 1870, Dr. Wood was disposed to retire from all official duties, on account of his advancing age and infirmity. On the occasion of his tendering his resignation of the Presidency of the American Philosophical Society, its Secretaries were authorized, as a committee, to request its withdrawal. In the communication

addressed to him in regard to it by them, he was assured on behalf of the members of the Society, that all continued to recognize him as "the most worthy representative it could have, not only where it holds its meetings, but in its correspondence with other learned bodies like itself."

After his retirement from active service in the Chair of Theory and Practice of Medicine in the University of Pennsylvania, he was made Emeritus Professor. He became also, soon afterwards, a member of the Board of Trustees of the University. In that Board, as Chairman of its Committee on the Medical Department, he exercised for many years an influence upon its affairs more important, perhaps, than that of any other individual member.

His distinctions were not confined to his own city. The College of New Jersey bestowed upon him the degree of LL.D. Besides being made honorary or corresponding member of the New York Academy of Medicine, and the Medical Societies of Massachusetts and Rhode Island, the same honor was conferred upon him by the *Société de Pharmacie* of Paris, the *Medico-Chirurgical Society* of Edinburgh, the *Royal College of Physicians* of Dublin; the *Silesian Society for Native Culture* of Breslau, *L'Academia de' Quiriti* of Rome, and the *Societas Cæsarea Naturæ Curiosorum* of Moscow, Russia. He attended, as a guest, two meetings of the British Association for the Advancement of Science, in 1848 and 1861. In the

former year, he was appointed delegate from the American Medical Association to the meeting, at Bath, of the British Medical Association. At his reception on this occasion, when his credentials were read, complimentary resolutions were passed, and the whole assembly rose to greet him, as the accredited and honored representative of his profession in America. During his last visit to England, in 1861, appropriate official and social courtesies were extended to him, as President of the American Philosophical Society, and of the College of Physicians of Philadelphia, by the officers and members of the Royal Society, and of the College of Surgeons and Physicians in London.

Three journeys to Europe were made by Dr. Wood, in 1848, 1853, and 1860-61-62. He visited in turn nearly all the principal countries of Europe, including Russia. Nor were these, to him, tours only of idle amusement or mere recreation. His natural and acquired industry, his real love of work as well as of knowledge, induced him to study carefully, sometimes almost exhaustively, every place and object of interest. Many volumes of his Journals of Travels have been preserved. They are very systematically written, and contain more valuable information, clearly and tersely conveyed, than most popular books by famous voyagers. A scientific note book was also kept by him, upon some particular subjects of interest and importance. Full, often elaborately detailed accounts

of his observations are given, of the most varied things and places; as, for example, the Museum of Northern Antiquities at Copenhagen, to the description of whose contents he gives fifteen letter-size pages of his Journal; the geological structure and indications of the banks of the Tiber; art galleries and the carnival in Rome; vineyards and vine culture near Perugia, on the way from Rome to Florence; the Lariborsière Hospital at Paris; the great International Exhibition at London; the reception of a deputation of philanthropists by Lord Palmerston; and the annual dinner of the British Medical Association. One of the pleasing minor incidents of his last visit to London, was the refusal of the proprietor of a leading drug establishment in that city to receive payment from him for some rather expensive medicines, on account of the services rendered to himself by Dr. Wood in his writings.

Some important concerns of the American Philosophical Society received careful and judicious attention from him during his journeys abroad. Among these were, his promotion, by personal address and correspondence with our Minister at St. Petersburg, of the donation to the Society of one of the copies of the reprint, authorized by the Emperor of Russia, of the Sinaitic Codex of the New Testament, brought to Europe by Professor Tischendorf. While in Paris, also, he found it necessary to devote some time to the affair of the Michaux legacy to this Society; which was then complicated by the reluctance of Madame Beziers,

widow of Michaux, to carry out, as desired, some of the required arrangements.

Our great civil war was going on during the last absence of Dr. Wood in Europe. Every mail brought news of battles, sometimes with reverses and sometimes successes, of the Union arms. So patriotic a man could not fail to be much moved by these events; and his Journal has many pages filled with reflections upon them, and the expression of his anxious solicitude for his country during its perils. There is interest in these expressions, as those of a sagacious man, looking forward as well as backward, at the career of this great Republic, then passing through its ordeal of fire. In 1861, he was, with others, much exercised about the possibility, at one time threatening, of Great Britain interfering to the advantage of the Secessionists. He predicts as the result of such an unwarranted action, certain disaster, if not ruin, to England; through advantage being taken by France, under Napoleon III., of the opportunity thus afforded to provoke new conflicts, not improbably ending in a general European war.

Confidently anticipating, at the beginning of 1862, the final, if not speedy triumph of the forces of the Union, he saw very distinctly at that period, the later prospect, which he indicated in these words: "But the problem appears to me much more difficult, what is to be done with the South when conquered, than will be the task of conquest." The plan which he favored

was one which many others have approved; perhaps more even now than at the close of the war, since the trial of a different but imperfectly successful policy; namely, "the establishment, in the States which had forfeited their rights under the Constitution, of provisional governments, with officers appointed by the President and Senate, and under regulations prescribed by Congress, until, by a gradual amendment in the character or material of the population they shall be again fitted to govern themselves as constituent parts of the Union."

Another, and still nearer, cause of anxiety began, early in the same year, to throw, as he wrote in his Journal, a deep shadow over Dr. Wood's future. This was the discovery that a cancerous tumor was beginning to threaten his wife's health and life. His plans of travel were altered in consequence. A voyage to Athens, Constantinople and Egypt was given up; and after some farther stay in Italy, the party traveled slowly toward Paris.

There, after careful surgical consultation, in April, 1862, the operation of excision was skilfully performed by the veteran surgeon, Velpeau, assisted by Nélaton, and Dr. Beylard, then of Paris, but formerly of Philadelphia. Dr. Wood's feeling upon the subject of his wife's illness and suffering was expressed thus in his Journal: "She and my country are the objects nearest my heart; and, if I know myself, I would willingly give up my own life, could I thereby secure the continued

enjoyment of life and happiness to either." Her life was prolonged, with tolerable health for a considerable period, until 1865.

Before Dr. Wood's embarkation upon his last journey abroad, in 1860, a farewell public dinner was given him by the members of the medical profession in Philadelphia, in testimony of their high respect, esteem and affection. The venerable and distinguished Dr. La Roche presided. The occasion was one of unusual interest. No physician in Philadelphia was ever more, if ever one so much, looked up to by those of all ranks and ages, as truly the head, the patriarch* of the medical profession in America.

At the time of his death, in 1879, Dr. Wood was a few days more than eighty-two years of age. On the subject of his funeral, I must cite the words of Dr. Littell, in his memoir, already mentioned: "His remains, followed by a long train of sorrowing friends, were silently interred at Laurel Hill, as the manner of Friends is to bury.† Not a word was uttered, not a note was heard, either at the house or at the grave. All instinctively felt that fulsome panegyric or trite remark would be alike out of place on such an occasion. They came 'to bury Cæsar, not to praise him.' But

* This expression was applied by Dr. Wood himself, in 1850, to his predecessor, Dr. Nathaniel Chapman. It may be said to be still preserved to Philadelphia, in the person of our distinguished surgeon, Professor S. D. Gross, who has received the very highest honors on both sides of the Atlantic.

† It need scarcely, perhaps, be here noted, that fitting discourse, by ministers or others, is frequent, although not universal, at the funerals of "Friends."

though no religious rite was observed, no comforting service performed, those who were present felt none the less deeply that the object of their love and veneration—the Christian gentleman, the representative physician, the knight of stainless record—had been gathered to his fathers after a well-spent life, ripe with years and honors, 'in the confidence of a certain faith, in the comfort of a reasonable, religious and holy hope, in favor with God, and in perfect charity with the world.' "

In person, Dr. Wood was rather tall; until the last few years of his life slender, and very erect in carriage. His features were regular, though not striking; he wore a peruke, and no beard. He was always dressed in black, and very neatly. His manners were dignified and formal; his whole appearance grave and sedate. To strangers, and those of slight acquaintance, he seemed rather to repel approach, and to produce a feeling of constraint. Amongst intimate friends, however, in social intercourse, this severity was relaxed; so that, although never demonstrative, he was quite affable, and, at times, genial. As Dr. Packard describes him, in his brief biographical sketch,* "whoever learned to know him found in him a faithful friend, a judicious counsellor, and a true man." His uniform courtesy entitled him to be designated, as he was at the dinner given to him by the profession in 1860, "the model gentleman." Using again some of the words of

*Transactions of the American Medical Association, 1879.

Dr. Littell, "his purity was that of the snow or lily; and no one in his presence ever ventured to indulge in ribald jest or unseemly remark." But once did I know him, in a long acquaintance, to be for a moment off his guard, in the measured dignity of his utterance; and then it was under somewhat unusual provocation. It seemed not improbable, however, that he had naturally an imperious temper; kept, upon principle, under admirable control.

His conversation was agreeable and often very instructive, though not brilliant. In one respect, he was extremely different from Dr. Nathaniel Chapman. Twice only, in very frequent professional and social intercourse, did I hear him utter a facetious remark; and, then, it was rather the dry wit which brings a smile than the humor which compels laughter.

One of Dr. Wood's early formed habits, not uncommon, perhaps, with toilsome authors, was that of doing most of his literary work late at night. From ten o'clock until two, three or four in the morning were his usual hours for such employment. So inveterate did this become, as a "second nature" with him, that when in advanced age he laid his pen almost entirely aside, he found it impossible to return to ordinary hours. He was still obliged, almost to the last, to turn night into day, and day into the time of his repose.

Open-handed benevolence was a marked trait of Dr. Wood's character. Privately, and to public institutions, he gave largely, although always with careful

discrimination and judgment. The University of Pennsylvania, the Pennsylvania Hospital, the Philadelphia College of Physicians, the American Philosophical Society and the Academy of Natural Sciences were the main recipients of his liberal donations during his lifetime; and several of these institutions also became principal legatees in his will.

Nor ought it to abate our appreciation of this munificent liberality, that, since his decease, the expected pecuniary value of these legacies has not been fully met, on account of the depreciation of securities,* and the inability of his cranberry plantation in New Jersey as yet to realize the large profits which he anticipated from it.

This last project, it appears needful to believe, was probably the least fortunate of Dr. Wood's undertakings. So sanguine, however, was he in regard to it, that he added for its extension a large number of acres to his farm at Greenwich, at prices larger than their owners, his neighbors, thought fit to ask of him. Here, as usual, mercenary aims were the farthest from his thoughts.

Mention has been before made, incidentally, of Dr. Wood's inclination towards a certain stateliness in his mode of living. In traveling during the summer through the State of Pennsylvania, and even in going

*His will was made in 1871, when gold was at a premium of 12½ per cent., and all other kinds of property were at a correspondingly high, if not higher range of prices, compared to those following the resumption of specie payments, and especially the depression which succeeded the "panic" of 1873.

to his farm in New Jersey, he would not unfrequently drive four-in-hand. This did not appear to be at all from affectation or love of display, for which he had no fondness; but rather from his conception of what belonged to his position in the profession and in general society, of which he was so prominent a member.

In all things, correctness, exactitude, method, and thoroughness were leading aims with Dr. Wood. These were shown above all other traits in his courses of instruction, private and public. No pains were spared to make every lecture complete, even in its smallest *minutiæ*. His manner as a lecturer was comparatively quiet, but sufficiently energetic; with enough animation always to secure attention, although never in the least approaching rhetorical excess. Others might easily obtain more admiration for their eloquence; no lecturer in the University was ever more effective, in conveying instruction and information to his classes. Especially in the abundance and excellence of the illustrations accompanying his lectures, he was in advance of almost all his contemporaries.*

In Dr. Wood's style as a writer, the same qualities of clearness and correctness were constantly manifested. If to any author, in science, philosophy, forensic or general literature, the term *faultless* may be applied, it may be to him. Nor was his manner correct

*If there was an exception to this, it was in the case of Professor Robert Hare. But he, as is well known, though a very illustrious chemist, and abounding in skilful and expensive experimentation, was not a superior lecturer.

merely; it was both elegant and forcible; varied without eccentricity, and polished, although devoid of ornament. His anniversary discourses on public occasions connected with the Pennsylvania Hospital, and his introductory and other addresses at the University, were models of their kind; and there are passages in his History of Christianity in India, which, without any of the brilliant adornments of a Macaulay, would not seem, in their manner, out of place upon the pages of a Bancroft or a Prescott.

His youthful ventures into the realm of poetic authorship have been already mentioned. The exact date of the composition of his longest versified work is not known to me. The copy which I possess was printed in Philadelphia, in 1864, without its author's name. It was dedicated to his wife, in language of admiration and tenderness; as the one who, as he therein says, "hast taught me how much a woman can love, and hast enabled me, through the feelings thou hast inspired, to measure the depth of affection of which the manly heart is capable."

This poem was an epic, in rhymed heroic verse, entitled, "First and Last; a Poem intended to illustrate the ways of God to man." It is divided into eighteen chapters (instead of books or cantos), making a 12mo volume of more than two hundred and fifty pages.

In reading it, one might easily forget that its author was a man of practical mundane experience and cyclopædic research, an authority in precise and applied

science. It is not without evidence of some power of imagination. Scarcely a false rhyme or incorrect measure, or even a harsh sounding line, occurs throughout. Yet it is almost equally without a spark of poetic genius. The "*mens divinior*," the Olympic gift, which comes not with any toil and is created by no strongest force of will, is wanting. Many scientists, like Sir Humphry Davy, have begun life with poetic aspirations; but no born poet, except Goethe, ever contributed important and permanent original gifts to science.* Still less, perhaps, ought we to look for the fire of genius where the whole character of a man's productions is that of great accumulation rather than of creation. Let us, then, without further criticism, accept on behalf of this epic, whose subject was the Miltonic one of the Fall of Man, and the scenes that followed it during the life-time of Adam and Eve, some of Dr. Wood's own earlier lines, written in the album of a friend, in 1831:

"What tho' no fire celestial glows
Along the burning line;
Nor stream of sweetest music flows,
Nor gems of fancy shine;

"And even should my hand untaught
Fail from the string to wrest
A note responsive to the thought
That dwells within my breast;

*The scientific mind has been more often associated with artistic than with poetic genius; as, very remarkably, in the case of Leonardo da Vinci. In our own times, Charles Kingsley and O. W. Holmes have been the most notable instances of the combination of attainments in science with great literary success.

"Yet partial friendship to these lays
Will not her ear refuse;
And, if she cannot justly praise,
Will labour to excuse."

Dr. Wood embodied in this epic poem his calm and deeply assured conviction of the truth and supreme importance of the Christian religion, which underlaid and supported the whole structure of his life.

A few lines from "First and Last" may suffice to set this forth:

"Lo! from the cross on which the Sinless died,
How streams the light of life on every side!
How penetrate remotest realms its rays,
Earth's darkest corners kindling into blaze!
To every land the messengers of love,
The Lord's elect, commissioned from above,
Bear the glad tidings; everywhere they sow
The seeds of truth, which, spirit-nurtured, grow
To a rich harvest. From each center spreads
The faith thus planted.

"Yet, now this, now that
Prevails. But of the two does victory wait
Most frequently on good. By slow degrees
Faith spreads her conquests. Over lands and seas
Is borne the banner onward, till at last
All nations bow before it."

Few men, of positive belief and devout feeling, make so little outward profession of religion as did Dr. Wood. But this is not difficult to account for. Not only was he a man of much natural reserve, especially in regard to the most sacred emotions of his heart, but this disposition was promoted by circumstances. Born into membership with the Society of Friends, and

educated mainly under its influences, his formal connection with it was severed by his marriage, his wife belonging to the Lutheran communion. He joined no other body. Often attending the meetings of Friends, and also not unfrequently accompanying his wife to her chosen place of worship, his religion was altogether unsectarian; but, for that, none the less real. His Journals, as well as his unprofessional published writings, manifest this clearly and often; and it was well understood by those who had the privilege of confidential intercourse with him. On one occasion, he expressed to a near relative his opinion, that the doctrine of the Society of Friends, of the immediate and perceptible guidance and teaching of the Holy Spirit (acknowledged, indeed, in some manner, by other denominations, but held most definitely and strongly by them) affords the only *scientific* basis for religious belief; since it gives to the historical revelation contained in the Scriptures a confirmation exactly corresponding to that *verification by experiment* which is the characteristic of modern science, since its improvement by means of the Baconian inductive philosophy.

But we must hasten towards our conclusion. To Dr. Wood, better than to most men, might be applied the poet's line: *Justum et tenacem propositi virum.*

If he had genius, it was a *genius for work;* a rare capacity for continued, indomitable, all-conquering labor. With this, he became an eminently successful man. As he wrote of Dr. Chapman,* "His career

* Lectures and Addresses, 1st Vol. p. 211.

throughout, from youth to manhood, from manhood to old age, has been in the highest degree prosperous and flattering; if the most kindly regards, general respect, a wide social and professional influence, a reputation limited only by the bounds of civilization, and the highest positions not political which an individual can attain in this country, may be considered as evincive of prosperity and honour."

In his own words, also, addressed, in 1853, to a class of medical students, we may set forth the noble motives which animated his life:

"Do not live solely for yourself. Do not seek wealth, station, influence, merely for your own personal gratification; but consider them as means for doing good, for spreading benefits around you, and for making an impression on the world, which, when you are gone to your rewards, will cause grateful recollections to cluster about your memory, and your example to be held up to the young for imitation in all future time."

So taught, and so lived, he whom, in the full ripening of his days, we have now lost. Truly he was a philosopher, in the old, first meaning of the word: a lover, acquirer and promoter of wisdom; and, with this, of goodness also. May his memory, and the influence of his example, never pass away from amongst us!

Stated Meeting, October 15, 1880.

Present, 12 members.

President, Mr. FRALEY, in the Chair.

Letters of envoy were received from the Botanical Garden at St. Petersburg, and the Meteorological Office in London.

Donations for the Library were received from the Botanical Garden at St. Petersburg, the Zoölogischer Anzeiger, Prof. Otto Schmidt of Strasbourgh; the Geographical Societies of Paris and Bordeaux; Revue Politique; London Nature; Chemists' Journal; Canadian Naturalist; Essex Institute; Harvard College Library; American Antiquarian Society; American Journal of Science; Franklin Institute; American Journals of the Medical Sciences, and of Pharmacy; Mr. Russell Thayer; the U. S. Coast Survey; Cincinnati Society of Natural History, and the Ministerio de Fomento of Mexico.

A report of the Committee on the Magellanic Prize essay was called for.

The death of Prof. Benjamin Pierce, at Cambridge, Oct. 6, aged 71, was announced by the Secretary, who read a notice of the deceased from the pen of Thos. Hill, late President of Harvard College.

Dr. Seidensticker described an amusing specimen of English poetry, which was read by the Secretary at his request; a dedication to the Chancellor of the University at Lund, and Senator of the Kingdom of Sweden, the most honorable Lord Count Charles Gyllenborg, *Discertatio Gradualis de Plantatione Ecclesiæ Svecanæ in America*, by Tobias Er. Biörck, Americano-Dalekarleus. Upsalæ Literis Wernerianis, A. D. 1700.

Mr. Lesley drew attention to Dr. P. J. J. Valentini's very satisfactory investigation of the probable fabrication of Landa's Mayan alphabet just published in the Proceedings of the American Antiquarian Society (No. 75, page 59 *et*

seq.), with the figures of the Landa text and from other sources.

Mr. Lesley said that so careful and precise a train of argument has seldom been pursued in a difficult case of Philology in dispute, and Dr. Valentini's conclusion will probably be generally accepted that Bishop Landa obtained from his catechumens the best figures which their imaginations suggested to them at the time for representing the vowels and consonants as he pronounced these before them; therefore, that his list of so-called alphabetic figures, being more or less the invention of the occasion, had no scientific or historic value then, and cannot now be used for deciphering Mayan or Mexican picture-writing in an alphabetic sense.

But had Dr. Valentini compared Landa's figures with those of Egypt, he would have been surprised at certain resemblances of a remarkably radical character; although these probably would not have led him to abandon his train of argument; as the resemblances cannot be considered sufficiently valid to oblige us to a different conclusion.

It is nevertheless astonishing to notice that while Landa's *first* B is, according to Valentini, represented by a foot-print, and that *path* and *foot-print* are pronounced *Be* in the Maya dictionary, the Egyptian sign for B was the human leg.

Still more surpising is it that the H of Landa's alphabet is a tie of cord; while the Egyptian H is a twisted cord. What connection can there be between a cord and the aspirate? Dr. Valentini explains, that in the Dresden codex a doubled-up rope frequently occurs, and that *tying-up days* to form a year was a common Mexican chronological expression. *Haab* is Mayan for *year*; and Valentini thinks that the rope symbol for *year* was given to Landa as the best letter *Ha* which his pupils could invent for him on the spur of the moment.

But the most striking coincidence of all occurs in the coiled or curled line representing Landa's U; for it is absolutely identical with the Egyptian curled U. The Mayan word for *to wind* or bend is *Uuc;* and that fact satisfies Dr. Valentini; but why should Egyptians, confined as they were to the Valley of the Nile, and abhorring as they did the sea and sailors, write their U precisely like Landa's alphabetic U in Central America? Birch gives *ha-ti* as the name of the Egyptian coiled U and of *the tow-line of a boat.*

There is one other remarkable conincidence between Landa's and the Egyptian alphabets; and by the way, the English and other Teutonic dialects have a curious share in it. Landa's D (T) is a disc with lines inside the four quarters, the allowed Mexican symbol for *day* or *sun.* So far as the sound is concerned the English *day* represents it; so far as the form is concerned the Egyptian "cake" ideograph for (1) *country*, and (2) *the sun's orbit*, is essentially the same. The Egyptian name of the latter is read *sen-nu.* Brugsch gives *S^{e}en* as *circumference*, perifery, the turn of the shadow, *S^{e}ennu* the entourage of a person, *S^{e}na* to make return, all of them with the circle as a determinative.

Mr. Lesley described the results of a recent visit to Saltville, in Virginia, made by Mr. Henry Carvil Lewis, of Germantown, on the suggestion that Tertiary shells might be found at the eastern corner of the little plain on which the salt and gypsum works stand.

Mr. Lewis reported that he had not only carefully collected all the univalves and bivalves of the locality but submitted them for examination to Mr. Tryon, of the Academy of Natural Sciences, who pronounced them all recent, and one of them as a species nowhere yet seen except in the Houston river, which flows along side of the plain, and the waters of which communicate with the wells, as described by Mr. Lesley some years ago.

Mr. Lewis had made a comparative collection of the same shells from the banks of the Houston and found the two suits identical.

On causing a number of pits to be dug he was surprised to find the surface stratum (three feet deep) to be a layer of these shells, most of the *unios*, &c., broken, but the gasteropods whole, mixed with pottery and embers. It is evidently a *kitchen trash deposit*. The shells did not extend beyond the area of the pottery. The Indians broke up the univalves to mix with the clay of the pottery, but the gasteropods must have been used only for culinary purposes.

He found under the layer of shells and pottery a layer of *local drift clay*, several feet thick, resting on the red gypsum salt muds, which are several hundred feet deep and occupy a basin a mile wide, eroded along an anticlinal arch of Lower Silurian limestones, the outcrops of which form the hill walls of the little enclosed secluded valley. The rocks dip 20° to 30° south-east; and from 50° to 60° north-westward towards the Houston river, outside of the enclosure. This erosion must have commenced when the Appalachian continent, crowned by Permian deposits, rose from the sea on the first construction of the anticlinal and synclinal folds. The salt clays then are probably of Trias age. That the gypsum is the result of the decomposition of the limestone layers is plainly shown in the shaft and tunnel workings; and it is confined to the walls of the basin, against which the horizontal salt-muds lie nonconformably.

Mr. Lesley embraced this occasion to make some remarks in opposition to the conclusions of Prof. Stevenson, expressed in his valuable Notes on South Virginia, read before this Society, Aug. 20, respecting the comparatively recent date of the great Virginia faults.

Prof. Stevenson does not positively assert that the faulting has succeeded the flexing by a longer or shorter interval of geological time, but he says: "It seems not wholly improbable that the faults are of later date than the disturbance which produced the comparatively gentle synclinal between

Wallen's ridge and the Clinch river;" and the whole tone of his concluding paragraphs leaves the impression that he assigns the Appalachian flexing to one age and the faults to another and later age. This would be in accordance with his opinions respecting the Pennsylvania anticlinals as preceding some of the coal deposits, published in his Reports of Progress KK and KKK of the Second Geological Survey of Pennsylvania.

Mr. Lesley said that his long study of the Coal Measures of the United States led him to entertain grave doubts of this. In fact he has repeatedly assigned the regular outspread and remarkably regular increase in the thickness of the Pittsburg coal bed towards the east, over the very large interval of country between its Ohio outcrops and its Maryland and Eastern Pennsylvania outcrops, as sufficient evidence that the Appalachian folds had no existence whatever up to the close of the Coal era.

This extensive study of the faults of Virginia and Tennessee in connection with the unbroken anticlinals of Pennsylvania had in like manner compelled him to see in them one single cause producing essentially the same effect in one and the same age.

Prof. Stevenson postulates the probability of later date for the faults on two classes of observations in Southern Virginia.

"1. That the course of the streams has not been determined by the lines of fault."

"2. That erosion along the faulted lines is essentially the same in character and extent with that in localities where no faults exist."

The second postulate Mr. Lesley considered essentially true, but held it as a proof of the community, not of the non-community of the faults with the other structural features.

He was obliged, however, to reject the first postulate. On the contrary, the topography illustrated by the maps and sections accompanying his paper on the Coal field of South Virginia, in Montgomery county, and his paper on Scott, Wise and Tazewell counties, Va. (Proc. Amer. Philos. Soc., Vol. IX. page 30, May, 1862, and Vol. XII, page 489, April, 1871) tell nothing more plainly than that the Clinch and other Southern river erosion is wholly and entirely and in detail most curiously determined by the faults, in the absence of which the whole water tree of that section of Virginia, and of all Eastern Tennessee would have been of a different character, in other words would have imitated the water-trees of Middle Pennsylvania, where such faults are unknown.

Mr. Lesley regretted that Prof. Stevenson was not present to explain and enforce his own views in opposition to this.

Dr. Barker read a letter from Dr. Henry Draper, of New York, announcing to the Society the first successful photographing of a nebula, the nebula of Orion, by himself, upon the 30th of September. Dr. Barker expressed his high satisfaction that this feat should have been accomplished first

in America, and by a member of this Society, and published in its Proceedings. He remarked on (1) the extreme sensitiveness of the plate, and (2) on the extraordinary perfection of the running machinery of the driving clock, which was required to hold the image steadily upon the plate for fifty minutes, ten minutes being hitherto considered the maximum.

The letter is as follows:—

271 Madison Avenue, New York,
October 9th, 1880.

My Dear Barker:—

I have succeeded in photographing the nebula in Orion. It took an exposure of fifty minutes which, as you can well imagine, was a hard test for the driving clock. This is the first time a nebula has been photographed. I used the new Clark triple objective of 11 inches aperture, mounted on the equatorial stand I made some years ago. This objective is especially corrected for the photographic rays.

The pictures show the mottled appearance of the bright portion of the nebula admirably. It will take some time to discuss the pictures taken since Sept. 30th, as comparisons must be made with the drawings of Lord Rosse, Bond and others.

The importance of the result turns on the fact that photographs will show with certainty any changes in the nebula and perhaps enable us to determine some of the laws ruling these elementary forms of matter. They may indicate the process of the genesis of solar systems.

If it suits your convenience will you call the attention of the Philosophical Society to this matter, and oblige

Yours truly,
Henry Draper.

Pending nominations Nos. 904, 909 to 920 were read.

Mr. Price reported in behalf of the Committee that a discourse on the life and character of the late President of the Society, George B. Wood, M.D., LL.D., was delivered by Dr. Henry Hartshorne, in the hall of the College of Surgeons, on the 11th instant, and asked that 1000 extra copies be printed for circulation, which was so ordered; and the thanks of the Society presented to the College for the free use of its room.

On motion it was resolved that the Curators be authorized to permit a copy to be made of Martin's portrait of Franklin.

The ballot boxes being examined by the presiding officer,

the following persons were declared duly elected members of the Society.

Mr. Alvan Clark, of Cambridgeport, Mass.
Mr. Alex. E. Outerbridge, of the U. S Mint.
Mr. Jacob B. Eckfeldt, of the U. S. Mint.
Mr. Patterson Dubois, of the U. S. Mint.
Mr. Lewis A. Scott, of Philadelphia.
Mr. Cadwalader Biddle, of Philadelphia.
Mr. Thos. H. Dudley, of Camden, N. J.
Mr. Isaac C. Martindale, of Camden, N. J.
Prof. Wm. Boyd Dawkins, of Manchester, Eng.
Dr. Daniel Draper, Ph.D., of New York City.

And the meeting was adjourned.

Stated Meeting, Nov. 5, 1880.

Present, 11 members.

President, Mr. FRALEY, in the Chair.

Letters accepting membership were received from Mr. Alexander E. Outerbridge, Jr., dated U. S. Mint, Oct. 26; Mr. Jacob B. Eckfeldt, dated U. S. Mint, Oct. 28; Mr. Patterson Dubois, dated U. S. Mint, Oct. 19; Mr. Lewis A. Scott, dated 1806 Locust street, Philadelphia, Oct. 19; Mr. Cadwalader Biddle, dated 1420 Walnut street, Philadelphia, Nov. 4; Mr. Isaac C. Martindale, dated Camden, N. J., Oct. 10; Prof. Wm. Boyd Dawkins, dated Boston, Mass., Oct. 21; and Dr. Daniel Draper, dated Meteorological Observatory, Central Park, N. Y., Oct. 19.

Letters of acknowledgment were received from the Société Royale, Upsal (99-103 inclusive; List of Members, and Catalogue, Part III); Société Hollandaise, Harlem (104); K. B. Akademie, Munich (102, 103); Naturforchende Gesellschaft, Freiburg in Baden (102, 103); Société des Sciences Physiques et Naturelles, Bordeaux (96, 98-104 inclusive); and the Royal Society, Edinburgh (105).

Letters of envoy were received from the Société Royale, Upsal, dated Nov. 1879; Fondation Teyler, and the Société Hollandaise, Mai, 1880. Harlem; Physicalische Gesellschaft, Berlin, July 20; Schweizerische Gesellschaft, Bern; Royal Irish Academy, Dublin, Aug. 1880; and the Department of the Interior, Washington, Oct. 27, 1880.

A letter of envoy containing a request for exchange of publications was received from the Société Zoologique et Botanique de Finlande, dated Helsingfors, June, 1880.

On motion the name of this Society was placed on the List of Correspondents to receive the Proceedings.

Donations for the Library were received from the Academies at St. Petersburg, Munich, Philadelphia and St. Louis; the Observatories at St. Petersburg, Upsal, Vienna, Munich and Turin; the Royal Society, Upsal; k.k. Geologischer Reichsanstalt, k.k. Geographische Gesellschaft, and Anthropologische Gesellschaft, Vienna; Geologische Gesellschaft, Berlin; Herrn F. Sandberger; Editors of the Fortschritte der Physic, Berlin, and the Zoologischer Anzeiger, Leipsig; Societies at Ulm, Bremen, Bern, Freiburg i B., the Hague, Harlem and Lille; Museum Teyler, Harlem; Société d'Anthropologie, Ecole Polytechnique and Revue Politique, Paris; Société de Géographie Commerciale, and Société des Sciences Physiques et Naturelles, Bordeaux; Royal Geographical Society, Geological Society, Zoological Society, Nature, and the Chemists' Journal, London; Natural History Society, and Mr. Samuel H. Scudder, Boston; Museum of Comparative Zoology, Cambridge; R. I. Historical Society, Providence; American Journal, New Haven; Mr. Isaac C. Martindale, Camden, N. J.; Medical News, Journal of Pharmacy, Mr. Henry Carvill Lewis, and Mr. Henry Phillips, Jr., Philadelphia; U. S. Department of the Interior, Washington; American Antiquaries, Chicago; Oriental and Biblical Journal, Clinton; National Museum, and Ministerio de Fomento, Mexico; and the Société Zoologique et Botanique de Finlande, Helsingfors.

The Committee to whom was referred the consideration

of the claim for the Magellanic Premium presented a report, which was ordered to lie over for consideration at the first stated meeting in December next.

An obituary notice of the late Dr. John Neill, prepared by Dr. Brinton at the request of the Society, was read by Dr. Horn.

The death of Mr. Peter McCall, a member of the Society, at Overbrook, Oct. 30, in his 73d year, was announced by Mr. Henry Phillips, Jr., who, on motion of Mr. E. K. Price, was appointed to prepare a notice of the deceased.

Dr. Horn presented two communications for publication in the Proceedings:

1. Critical notes on the species of *Selenophorus* of the United States.

2. A review of the species *Anisodactylus* inhabiting the United States.

Mr. Chase offered a list of his papers published by the Society.

Mr. Lesley exhibited some recently executed works of the Geological Survey:

1. A printed sheet of oil well sections and profile colored to show the thinning away of the Catskill formation, &c., north-westward along the valley of the West Branch Susquehanna river, above Lock Haven, by Mr H. M. Chance;

2. A hand-colored printed map of the Philadelphia belt, by Mr. C. E. Hall;

3. A MS. map of part of the Mahanoy and Shenandoah anthracite basins in Schuylkill county, showing the structure of the Mammoth bed by contour lines, by Mr. Chas. A. Ashburner and Mr. Arthur Sheafer.

Pending nominations Nos. 909, 920, and new nominations Nos. 921, 922 were read.

Mr. Fraley reported that he had received and paid over to the Treasurer, $131.28, being the last quarterly payment on the Michaux Legacy, due Oct. 1, 1880.

Mr. Fraley informed the Society that a petition for a new transcription, called for by the French Minister of Finance, had been duly executed and forwarded to Paris, and that

the Minister of Finance had authorized a new transcription on the books of the office at Paris.

Mr. Briggs addressed the Society, urging some action for applying the Magellanic funds to the rewarding of discoverers and inventors who did not apply for the premium.

Mr. Fraley thereupon gave a short history of the original bequest, the accumulation of the extra fund, the legal opinion of Mr. Horace Binney respecting its use, its application by the Society to publication, the establishment of the extra-Magellanic premium, the publication of other premiums, and the appointment of a committee on premiums at large.

On motion it was

Resolved, That the Board of Officers and Members in Council be requested to take into consideration the present regulations in regard to the award of the Magellanic Premium, and to report, if they may deem any change expedient, such modifications as may lead to the awarding of said Premium for objects of scientific discovery mentioned in the original donation.

And the meeting was adjourned.

Obituary Notice of Dr. John Neill. By Dr. Brinton.

(*Read before the American Philosophical Society, Nov.* 5, 1880.)

Among the numerous surgeons of distinction who have given lustre to medical science in Philadelphia, the late Dr. Neill deservedly stood in the front rank. He came of a race of physicians, his father and both his paternal and maternal grandfathers having been members of that profession. He was born in Philadelphia, July 9th, 1819, and received both his academic and medical degrees from the University of Pennsylvania, the latter in 1837. The whole of his subsequent life was passed in this city, where he soon acquired large surgical and general practice. At various periods he occupied prominent positions in relationship to his profession. It will be sufficient to mention the leading ones of these. As early as 1845 he was appointed Demonstrator of Anatomy in the University of Pennsylvania, and thirty years later, Professor of Clinical Surgery in the same institution. For several years after 1864, he was Professor of General Surgery in the medical department of Pennsylvania College, an educational organization not now in existence. At various epochs he was surgeon to the Pennsylvania Hospital, to the Philadelphia Hospital, to Wills Hospital, and Consulting Surgeon to the Presbyterian Hospital.

During the war of the Rebellion, especially in its earlier years, he was actively engaged in rendering professional services to the wounded soldiery.

In the summer of 1861 he was appointed by the General Government to establish army hospitals in this city, and the first eight organized and constructed here were put in working order under his supervision. At the height of the conflict, when the Southern forces invaded this State, he was appointed Medical Director of the militia and emergency troops of the State. In fulfilling the duties of this office, he was at Gettysburg after the battle, taking care of the wounded, and established a hospital at Carlisle, and also those at Hagerstown, Md.

Dr. Neill was a writer as well as a practitioner. His contributions to literature were principally, if not exclusively, confined to subjects relating to medical and surgical science, and were usually in the form of articles in medical periodicals. He is known as the author of several anatomical works treating of the arteries, veins and nerves, and also of the surgical and anatomical portions of a very popular work for students, entitled "A Compendium of Medical Science," published about twenty-five years ago.

A Review of the Species of ANISODACTYLUS *inhabiting the United States.*

By George H. Horn, M.D.

(*Read before the American Philosophical Society, Nov.* 5, 1880.)

It is difficult to understand why this genus has passed almost entirely neglected, and why so much confusion and consequent synonymy prevail, when a short study will demonstrate how easily the species may be grouped and each separated from the other by sharply defined structural characters.

The division of the genus into three subgenera by the form of the anterior tibial spur is long known, but the characters which follow seem for the most part to have entirely escaped notice. The first of these, taken from the structure of the posterior tarsus, and the length of the first joint as compared with the next two, needs no further explanation.

The presence of two or one setigerous puncture on each side of the clypeus near the anterior margin is a character of very great importance and may be used elsewhere in the Carabidæ in the separation of smaller groups of species in the manner indicated in the accompanying table.

The structure of the underside of the male tarsi is also very useful here, it affords a means of supplementing any character which may be drawn from the two sexes together, separating very sharply species which appear superficially closely allied.

In the *dilatatus* and *sericeus* groups I have been unable to distinguish any true dorsal puncture. In all the other species the dorsal puncture is distinct and will be found at the posterior third of the elytra on or very close to the second stria.

All the species have the spurs of the posterior tibiæ slender and rather

long, in one, however (*immanis*), the spurs are apparently more closely approximated at base, and are broad, slightly foliaceous at the sides and obtuse at tip.

Characters of minor importance will be found under the various group headings.

Having, by means of the characters above indicated, approximated those hitherto recognized species which seemed closely related, numerous forms have been found which have refused to be separated, especially near *rusticus* and *porosus*. I have accordingly placed these as synonyms, and in defence of that course will state, that the mass of material which I have had before me from my own and Dr. LeConte's cabinet fully warrants such a procedure.

In the bibliography, which will be found at the end of the paper, I have marked those species with an asterisk (*) of which I have seen types or specimens compared directly therewith.

The following is the table of groups:

Terminal spur of anterior tibiæ trifid.....A.
Terminal spur of anterior tibiæ dilated at middle.....B.
Terminal spur of anterior tibiæ slender.....C.

A. Posterior tarsi slightly flattened, shorter than the tibiæ, the first joint very little longer than the second. Hairy species.....A—a
Posterior tarsi slender, as long as the tibiæ, the first joint nearly as long as the next two together. Glabrous species.....A—b

B. Posterior tarsi slender, equal to the tibiæ, first joint long; first joint of middle tarsus ♂ pubescent at tip. Black species.....B—a
Posterior tarsi flattened, first joint short; first joint of middle tarsus ♂ glabrous beneath. Species bi-colored or metallic.....B—b

C. Elytra with distinct dorsal puncture, first joint of middle tarsus ♂ glabrous beneath or with a very small pubescent space. Elytra smooth, surface more or less metallic.....C—a
Elytra without dorsal puncture, first joint of middle tarsus ♂ pubescent over half its surface. Elytra densely punctulate, surface black, subopaque, and finely pubescent.....C—b

Group A—a is peculiar to the Pacific region, C—b to the Atlantic, the other groups contain species from both sides of the continent.

A—a has been called *Dichirus;* A—b, *Triplectrus;* B—a, B—b, *Anisodactylus;* C—a, *Haplocentrus.*

A—a, *dilatatus* Group.

Species more or less hairy. Terminal spur of anterior tibiæ ♂ ♀ trifid. Posterior tarsi slightly flattened, the first joint very little longer than the second, the fourth feebly emarginate. Elytra striate, feebly sinuate at tip, the intervals biseriately punctate, dorsal puncture not distinct.

Male. Anterior tarsi broadly dilated, the first four joints pubescent beneath, middle tarsi less dilated, pubescent or not.

Female. Anterior and middle tarsi slightly broader than the posterior, not pubescent beneath.

In consequence of the hairy head, it is difficult to determine the number of clypeal setigerous punctures. The first two species below have two certainly, and *piceus* but one.

The species of this group are as follows :

Thorax very distinctly narrowed behind, the sides arcuate.

Hind angles of thorax obtuse. Intervals of elytra very irregularly biseriately punctulate. Middle tarsi ♂ not pubescent beneath.

Posterior and middle tibiæ ♂ coarsely tuberculate externally. Sides of thorax beneath impunctate.....1. **strenuus** Horn.

Tibiæ spinulose externally. Thorax beneath punctate..2. **dilatatus** Dej.

Hind angles of thorax distinct. Intervals of elytra very regularly and closely biseriately punctulate. Middle tarsi ♂ with joints 2—4 pubescent beneath.

Spurs of hind tibiæ slender and acute.

Hairs of surface short and erect. Thorax beneath with few obsolete coarse punctures.....3. **obtusus** Lec.

Hairs of surface long and scarcely erect. Thorax beneath with numerous coarse and deep punctures.....4. **pilosus**, n. sp.

Spurs of hind tibiæ short, broad and dilated at tip, 5. **immanis**, n. sp.

Hind angles of thorax sharply rectangular.....6. **brunneus** Dej.

Thorax scarcely narrower at base, sides feebly arcuate, hind angles obtuse. Clypeus with one setigerous puncture on each side. Middle tarsi ♂ pubescent beneath. Feebly pubescent.....7. **piceus** Menét.

1. **A. strenuus** Horn. Our largest species, easily known in the group by its more robust and convex form and by the under side of the thorax being opaque and impunctured. The middle and posterior tibiæ in the male are roughly tuberculate on the outer margin. I have not seen the female. Length .60 inch ; 15 mm.

Two specimens ; Fort Tejon, California,

2. **A. dilatatus** Dej. With this species I unite *hirsutus*. It is much more depressed than the preceding species and the elytral intervals feebly convex. The middle and posterior tibiæ are simply spinulose externally, and the under side of the thorax sparsely obsoletely punctate. The punctures of the elytral intervals are coarse and very irregularly disposed. Length .32—.44 inch ; 8—11 mm.

Occurs nearly everywhere in California.

3. **A. obtusus** Lec. Similar in form to *dilatatus*, but smaller and with the hind angles of the thorax quite distinct but not prominent, and the disc more densely punctured. The underside of thorax has but few coarse punctures and these not deep. The hairs of the surface are short and erect, those of the elytra arising from the interstitial punctures which are very regularly and densely placed. The middle tarsi of the male have the three intermediate joints pubescent beneath. Length .30 inch ; 7.5 mm.

Occurs at San Jose, California.

4. **A. pilosus**, n. sp. Form rather narrow, elongate, piceous, feebly shining, pubescent, legs rufous. Head very coarsely and deeply punctured and with long hairs, clypeus with two larger setigerous punctures on each side. Thorax a little wider than long, narrowed behind, sides arcuate anteriorly, oblique posteriorly, hind angles distinct but not prominent, base slightly arcuate on each side, disc moderately convex, coarsely and deeply punctured, the punctures regularly placed, surface with moderately long hairs. Elytra a little wider than the thorax, oblong, sides very slightly arcuate, surface finely striate, intervals flat and regularly biseriately closely punctate, each puncture with a rather long semi-erect hair. Thorax beneath very coarsely and deeply punctate, metasternum at sides coarsely punctate, abdomen at sides more sparsely punctulate. Length .28 inch ; 7 mm.

This species is much more slender in form than *obtusus*, and differs also in the longer hairs of the surface and the sculpture of the thorax beneath. Sexual characters as in *obtusus*.

Occurs in the San Joaquin Valley, California. (Blüthner.)

5. **A. immanis**, n. sp. Oblong, depressed, piceous, feebly shining, pubescent, legs rufous. Head coarsely but not deeply punctate, with short erect hairs, clypeus with one setigerous puncture on each side. Thorax broader than long, narrowed posteriorly, sides in front arcuate, posteriorly oblique, hind angles distinct but not prominent, base on each side slightly arcuate, disc feebly convex, coarsely but not deeply punctate, surface with very short erect hairs. Elytra wider than the thorax, oblong oval, sides slightly arcuate, surface finely striate, intervals flat and rather finely and closely biseriately punctulate, with very short erect hairs. Thorax beneath with a few coarse punctures in front. Metasternum at sides and abdomen sparsely punctulate. Hind tibiæ with short, broad, spathuliform terminal spurs. Length .34 inch ; 8.5 mm.

I have seen but two females of this species, which bears considerable resemblance to *obtusus*, differing in the structure of the posterior tibial spurs. This character is so remarkable and unexpected in this genus that I would have passed the specimens as probable monstrosities, but the structure precisely agrees in the hind tibiæ of both specimens.

Two specimens ; San Joaquin Valley, California (Blüthner).

6. **A. brunneus** Dej. Resembles *piceus* in form but smaller, with the hind angles of the thorax rectangular and slightly prominent. I have never seen any specimen which agrees with the description excepting the type of Dejean in Chaudoir's collection. I have, however, in my cabinet an immature specimen which agrees with my recollection of that type, but which proves to be a Harpalus by the biseriately papillose tarsi. As the Dejean type is a female, a renewed examination is necessary to prove its generic position.

7. **A. piceus** Menét. In this species the thorax is very little narrowed behind, the posterior angles obtuse. The clypeus has but one setigerous

puncture on each side. The punctures of the elytral intervals are rather irregularly placed and are usually closer on the inner side of the interval than the outer. Length .36 inch ; 9 mm.

This is the most common species of the Pacific coast, occurring from Alaska to the Peninsula of California and the islands adjacent, it extends inland to Idaho and Utah.

A—b, *rusticus* Group.

Species oblong or somewhat oval, glabrous, surface usually opaque, rarely shining (*dulcicollis*) or metallic (*harpaloides*). Terminal spur of anterior tibiæ ♂ ♀ trifid. Posterior tarsi slender, as long as the tibiæ, the first joint as long as the next two, the fourth joint emarginate. Elytra striate, intervals impunctate, a distinct dorsal puncture, tip distinctly sinuate.

Male. Anterior tarsi broadly dilated, the first four joints densely pubescent beneath, middle tarsi dilated joints 2—3—4 densely pubescent, the first with a small pubescent space at tip (except in *harpaloides* where there is no pubescense).

Female. Anterior and middle tarsi not dilated (except in *harpaloides* and *opaculus* where the first joint is broader and stouter).

The clypeus on each side has but one setigerous puncture, except in *carbonarius* where there are two.

The dilatation of the first joint of the anterior tarsus of the female is not a character of great value. It is well marked in the two above mentioned, but less in the second than in the first. In *dulcicollis* also a slight thickening may be observed.

The species of this group are distinguished in the following manner :

Clypeus with one setigerous puncture on each side, prosternum at middle smooth, not pubescent.
  Surface shining.
    Surface with metallic lustre, aeneous, legs and antennæ pale.
      8. **harpaloides** Ferté.
    Surface black, shining, legs black.....9. **dulcicollis** Ferté.
  Surface opaque, very distinctly alutaceous.
    Form elongate parallel, thorax not narrowed in front, widest near the middle.....10. **opaculus** Lec.
    Form more or less oval, thorax narrowed from base to apex, widest at base.....11. **rusticus** Say.
Clypeus with two setigerous punctures on each side, prosternum at middle punctured and pubescent.
  Surface opaque, form elongate, thorax nearly as wide at apex as at base.....12. **carbonarius** Say.

8. **A. harpaloides** Ferté. An oblong species, shining, with greenish or bluish metallic surface lustre. The clypeus has but one setigerous puncture on each side. Thorax as wide at base as apex, the sides feebly

arcuate. Elytra oblong, parallel or with the sides feebly arcuate, surface striate, intervals smooth and flat, a dorsal puncture in the usual position. The body beneath is smooth. Legs and antennæ rufous. Length .36—.40 inch ; 9—10 mm.

The *male* has the anterior tarsi dilated, the first joint much less so than the others and without pubescence beneath, the three following joints are normally pubescent ; middle tarsi less dilated, first joint glabrous, next three pubescent. In the *female* the first joint of the anterior tarsus is rather broadly dilated and thickened, slightly prolonged under the second joint, not pubescent beneath, joints 2—5 slender ; middle tarsi slender.

The resemblance of this species to *Harpalus amputatus* is worthy of mention, they are almost undistinguishable by superficial comparison. It is remarkable also that the first joint of the anterior tarsus of the male should be so feebly dilated and that of the female so much so.

Occurs in the Gulf States.

9. **A. dulcicollis** Ferté. Form somewhat oval, black, shining, legs piceous. Thorax broader at base than apex and as wide as the elytra, sides moderately arcuate, hind angles obtuse, basal impressions moderate and with very few punctures. Elytra oval, sides moderately arcuate, surface striate, intervals smooth, slightly convex, dorsal puncture distinct. Body beneath smooth, shining. Length .44 inch ; 11 mm.

The anterior tarsus of the *male* is normally dilated, the first joint pubescent beneath, the middle tarsi nearly as broadly dilated, the first joint pubescent at tip.

In the female the tarsi are slender, the first joint of the anterior is however somewhat stouter than in *rusticus*. The elytra are less shining than in the male.

Occurs in the Gulf States and Missouri.

10. **A. opaculus** Lec. Elongate oval, subparallel, black, opaque. Thorax not wider at base than apex, sides feebly arcuate, hind angles obtuse, basal impressions feeble, surface impunctate. Elytra oblong, sides feebly arcuate, surface finely striate, intervals flat, at apex 3—5—7 with a few feebly impressed punctures, dorsal punctures normal. Body beneath smooth, shining, legs piceous. Length .44 inch ; 11 mm.

The *male* sexual characters are as in *dulcicollis*. The characters of the female are also similar but the first joint of the anterior tarsus is a little stouter but much less so than in *harpaloides*.

Having seen a typical specimen of *elongatus* Chaud., I have no hesitation in placing it with the present species, the differences given by that author are certainly more of an individual character than of a specific nature.

Occurs in Texas.

11. **A. rusticus** Say. With this species I unite not only those already suppressed by Dr. LeConte (List p. 12) but also *merula* Germ. and *haplomus* Chaud. The accumulation of large numbers of specimens shows

them to be inseparable. Chaudoir proposes to separate these forms by their dentate or simple humeri, *merula* and *pinguis* with dentate humeri, and *rusticus* and *haplomus* with simple humeri. These characters are not by any means as constant as could be desired. It is true that forms can be selected typifying about four species, but the vast mass of the specimens would occupy the intermediate ground. Locality also has but little to do with the variation except that the form usually called *merula* appears to be peculiar to the Southeastern States. Length very variable .36—.56 inch; 9—14 mm.

The *male* has the first four joints of the anterior tarsi dilated and pubescent beneath, the middle tarsi are nearly as widely dilated, the first joint very feebly pubescent at tip only. In the *female* the anterior tarsi are slightly broader than the middle, the first joint not stouter.

Occurs everywhere in the Atlantic region east of the Rocky Mountains.

12. **A. carbonarius** Say. Form oblong, black, feebly shining ♂ or opaque ♀. Clypeus with two setigerous punctures on each side. Thorax broader at base than apex, sides feebly arcuate, hind angles obtuse, base truncate, side margin depressed, broadly near the base, base externally and side margin punctulate, distinctly ♂, obsoletely ♀. Elytra oblong, sides nearly parallel ♂, or slightly arcuate ♀, surface finely striate, intervals slightly convex ♂ or flat ♀. Body beneath smooth, shining. Prosternum punctured and with erect hairs, intercoxal process coarsely punctate. Length .52 inch; 13 mm.

In the *male* the anterior and middle tarsi are dilated and pubescent beneath, the first joint of the middle pubescent over half its surface. In the *female* the characters are as in *rusticus*.

Occurs from the Middle States to Colorado.

B—a, *nigrita* Group.

Species oblong, surface either shining or opaque, glabrous. Terminal spur of anterior tibiæ ♂ ♀ dilated at middle. Posterior tarsi slender, nearly as long as the tibiæ, the first joint nearly as long as the next two together, the fourth joint feebly emarginate. Elytra striate, often very finely, intervals rarely punctulate, tip distinctly sinuate, second stria with a distinct dorsal puncture.

Male. Anterior tarsi broadly dilated, the first four joints densely pubescent beneath, middle tarsus nearly as widely dilated, the first joint pubescent at tip only, the next three densely pubescent over their entire surface.

Female. Anterior and middle tarsi slender or very feebly broader, not pubescent beneath.

The clypeus may have one or two setigerous punctures on each side, the number of species in the first series being greater than the second. Those with one puncture follow naturally after the *rusticus* group.

The species are as follows:

Clypeus on each side with one setigerous puncture.
Surface opaque, elytra feebly striate, especially at tip.
Hind angles of thorax obtuse, sides regularly arcuate, base as wide as the elytra.....13. **furvus** Lec.
Hind angles of thorax sharply rectangular, sides of thorax slightly arcuate posteriorly, base narrower than the elytra (Pacific coast species).
Intercoxal process and middle of second abdominal segment punctured, punctures with short setæ. Metasternum in front and behind punctured.
Thorax feebly narrowed posteriorly, basal impressions very feeble, surface entirely punctured....14. **semipunctatus** Lec.
Intercoxal process and metasternum smooth.
Thorax with broad but very shallow basal impressions. Elytra broad, sides distinctly arcuate.....15. **consobrinus** Lec.
Thorax with rather deep linear impressions, Elytra nearly parallel.....16. **californicus** Dej.
Surface shining in both sexes, elytra more deeply striate.
Elytral intervals feebly convex, quite distinctly but sparsely punctulate, elytra oblong, sides nearly parallel, surface feebly shining. 17. **interpunctatus** Kby.
Elytral intervals convex, smooth, elytra oval, sides arcuate, surface shining; form more robust.....18. **agricola** Say.
Clypeus on each side with two setigerous punctures.
Hind angles of thorax obtuse.
Side margin of thorax very distinctly depressed and with the base punctulate.....19. **Harrisii** Lec.
Side margin of thorax scarcely depressed.....20. **nigerrimus** Dej.
Hind angles of thorax distinct, nearly rectangular.
Elytral intervals distinctly but sparsely punctulate, sides of elytra nearly straight, subparallel.....21. **nigrita** Dej.
Elytral intervals smooth, shining, sides of elytra distinctly arcuate, form more robust.....22. **melanopus** Hald.

To this group belongs *A. signatus* Illig., of Europe and Asia. It resembles *semipunctatus* Lec., and has but one setigerous puncture on each side of the clypeus. The intercoxal process is smooth. It differs from any of the species of the group by the first joint of the middle tarsus of the male having no pubescence beneath.

13. **A furvus** Lec. Oblong oval, black, opaque. Clypeus with one setigerous puncture each side. Thorax very little wider at base than at apex, sides feebly arcuate, hind angles obtuse, side margin feebly depressed, surface smooth at middle, finely punctured at base and sides. Elytra finely striate, intervals flat, dorsal puncture normal, surface opaque, more so in ♀. Body beneath smooth, shining. Length .44—.50 inch; 11—12.5 mm.

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In the *male* the anterior tarsi have the first four joints dilated and pubescent beneath, the middle nearly as wide, the first joint pubescent at tip only, the following three densely pubescent.

The *female* has the tarsi without pubescence, the anterior a little broader than the middle.

This species resembles some of the forms of *rusticus*, but the group characters readily distinguish it.

Occurs from Georgia to Louisiana.

14. **A. semipunctatus** Lec. Form oblong, moderately robust, black, subopaque. Clypeus with one setigerous puncture each side. Thorax broad, slightly narrowed behind, sides feebly arcuate, hind angles rectangular but not prominent, side margin narrowly depressed, surface punctulate, more densely at sides and base. Elytra a little wider than the thorax, finely striate, intervals flat and very obsoletely punctulate on the disc, distinctly punctate at tip, dorsal puncture normal. Metasternum at side obsoletely punctured, in front and behind also, the first ventral segment and prosternum with fine punctures bearing short setæ. Length .50 inch ; 12.5 mm.

The sexual characters are as in *furvus*.

A. similis Lec. and *puncticollis* Chaud. are the same. The first of these names is somewhat older than that which I adopt and has been rejected in favor of a more expressive name, no injustice being done to the original author.

15. **A. consobrinus** Lec. Similar to the preceding but with the thorax more narrowed behind and the hind angles sharply rectangular ; the basal impressions are vague and very shallow. The elytra are similar, but without obsolete punctures on the intervals and the sides are more arcuate. The body beneath is smooth. Length .30 inch ; 12.5 mm.

The sexual characters as in *furvus*.

Occurs in California in the middle and southern portions.

16. **A. californicus** Dej. Resembles the preceding but the form is more slender and the thorax less broad with the hind angles less prominent ; the basal impressions are much deeper and more sharply defined and the surface much less densely punctulate. The body beneath is smooth. Length .50 inch ; 12.5 mm.

While in the two preceding species the sexes are nearly equally opaque, here the male is decidedly more shining.

Sexual characters as in *furvus*.

Occurs in Oregon, California and Nevada.

17. **A. interpunctatus** Kby. Oblong, black, shining (slightly opaque ♀). Head sparsely, finely punctulate, clypeus with one puncture on each side. Thorax much broader than long, base and apex equal, sides feebly arcuate, margin narrowly depressed, hind angles rectangular not prominent, basal impressions moderately deep, disc moderately convex, very sparsely punctulate at middle, more densely along the base and side. Ely-

tra oblong, sides nearly parallel, moderately deeply striate, intervals feebly convex and sparsely obsoletely punctulate. Body beneath smooth. Length .48 —.50 inch; 12—12.5 mm.

Sexual characters as in *furvus*. The female is much less shining than the male and the fine punctuation of the intervals much less distinct.

This is the species which has heretofore borne the name *nigrita* and for which Chaudoir suggested the name *Lecontei*. The Kirbyan description will fit equally well either to the present species or the true *nigrita* and I prefer to adopt the above name rather than suggest a new one.

Occurs in Pennsylvania, Vancouver and Canada (Kirby).

18. **A. agricola** Say. Form oblong, moderately robust, black, shining. Thorax broad, base and apex equal, sides moderately arcuate, hind angles rectangular, not prominent, margin narrowly depressed, basal impressions well defined, linear, disc convex, surface smooth with few punctures along the base and margin. Elytra slightly oval, striæ deep, intervals moderately convex, smooth and impunctured. Body beneath smooth. Length .44—.56 inch; 11—14 mm.

Sexual characters as in *furvus*.

This is the most robust and convex species of the present group.

Occurs in Missouri, Kanas and Georgia.

19. **A. Harrisii** Lec. Oblong oval, black, shining. Clypeus with two setigerous punctures each side. Thorax moderately broad, sides regularly arcuate, widest at middle, hind angles very obtuse, side margin depressed more widely behind, disc moderately convex, median line distinct, basal impressions shallow, basal region and depressed margin punctulate. Elytra moderately deeply striate, intervals slightly convex, smooth. Body beneath smooth, a few punctures on the intercoxal process of the abdomen and on the front and posterior portions of the metasternum. Length .44—.48 inch; 11—12 mm.

Sexual characters as in *furvus*.

Occurs from Newfoundland to Pennsylvania.

20. **A. nigerrimus** Dej. Thorax moderately convex, side margin very slightly depressed at middle and not at all at the basal angles, the basal impressions are feeble, shallow and but little punctulate. The other characters are those of the preceding species. Length .44 inch; 11 mm.

Sexual characters as in *furvus*.

Occurs in the New England and Middle States.

21. **A. nigrita** Dej. The description already given of *interpunctatus* applies so exactly to this that I find no differences except, that in the present species there are two clypeal punctures on each side while in that there is but one. Length .50 inch; 12.5 mm.

Sexual characters as in *furvus*.

The determination of the present form as the true *nigrita* Dej. (*interpunctatus* ‡ Lec.) is made from a specimen compared by Chaudoir with Dejean's types.

Occurs in the New England and Middle States.

22. **A. melanopus** Hald. As the preceding species is parallel with *interpunctatus* so is the present with *agricola*. The differences, other than those drawn from the clypeus, are hardly of sufficient moment to be considered specific, and it is worthy of note that the present and preceding species differ from each other in the same manner as do 17 and 18. Length .52—.56 inch ; 13—14 mm.

Occurs in Pennsylvania and Illinois.

B—b, *discoideus* Group.

Species oblong, surface shining (at least in ♂), either glabrous or with very fine pubescence, variable in color and lustre. Terminal spur of anterior tibiæ dilated at middle. Posterior tarsi slightly flattened, shorter than the tibiæ, the first joint but little longer than the second, the fourth emarginate. Elytra striate, tip sinuate, intervals either smooth or punctulate alternately, dorsal puncture distinct.

Male. Anterior tarsi broadly dilated, the first four joints pubescent beneath. Middle tarsi feebly dilated, first joint glabrous, the next three feebly pubescent.

Female. Anterior and middle tarsi not dilated nor pubescent beneath. Surface usually less shining.

All the species of this group have two setigerous punctures on each side of the clypeus, except *nivalis*. In all, the basal impressions of the thorax are well marked.

The species are as follows :

Clypeus with one setigerous puncture on each side.

Color variable, elytra ♀ subopaque and often ferruginous with discal piceous space. Intervals impunctate..... .23. **nivalis**, n. sp.

Clypeus with two setigerous punctures on each side.

Intervals of elytra impunctate, elytra in part at least and legs testaceous.

Thorax piceous, testaceous at the sides.....24. **discoideus** Dej.

Thorax entirely piceous.....25. **baltimorensis** Say.

Intervals of elytra alternately punctulate.

Punctulate near the apex only.....26. **pitychrous** Lec.

Punctulate their entire length.....27. **porosus** Motsch.

23. **A. nivalis**, n. sp. Form oblong, moderately elongate, piceous, elytra variable, either piceous or brownish-testaceous, with a darker discal space, and subopaque ♀. Head nearly smooth, clypeus with one setigerous puncture each side. Thorax broader than long, narrowed behind, sides arcuate in front, sinuate posteriorly, hind angles obtusely rectangular, disc moderately convex, median line distinct, basal impressions short, deeply impressed and punctured. Elytra wider than the thorax, sides subparallel ♂ or slightly arcuate ♀, apex feebly sinuate, moderately deeply striate, intervals flat, surface shining ♂ or subopaque ♀, dorsal puncture normal. Body beneath smooth, first ventral segment punctured at middle. Legs piceous. Length .36—.44 inch ; 9—11 mm.

In the *male* the first four joints of the anterior tarsi are dilated (the first joint rather feebly) and pubescent beneath, middle tarsi less dilated, the first joint not pubescent, the next three pubescent. In the *female* the anterior and middle tarsi are slightly dilated but not pubescent beneath.

The males are usually entirely piceous in color, while in the females the elytra are brownish-testaceous with a large, darker discal space. There are however exceptions in both sexes. This species has heretofore been considered a variety of *pitychrous*, but beside the clypeal setæ, the present species differs in the absence of punctures on the alternate intervals near the tip, and the entire absence of any metallic surface lustre.

Occurs in Nevada, northern California, Oregon and Vancouver.

24. **A. discoideus** Dej. Form oblong, moderately elongate, piceous, sides of thorax and elytra and legs testaceous. Head piceous, clypeus with two setigerous punctures on each side. Thorax very little wider than long, narrowed at base, sides arcuate in front, sinuate posteriorly, hind angles sharply rectangular, side margin very narrowly depressed, disc moderately convex, smooth, punctured along the base, basal impressions short and deep. Elytra wider than the thorax, rather deeply striate, intervals slightly convex and smooth. Body beneath smooth, intercoxal process slightly punctulate. Length .44 inch ; 11 mm.

The anterior tarsi of the *male* are not broadly dilated and the first joint has very little pubescence at tip, the middle tarsi are rather slender, the first joint glabrous, the next three feebly pubescent. In the *female* the anterior and middle tarsi are scarcely broader than the posterior.

Occurs from Pennsylvania to Missouri.

25. **A. baltimorensis** Say. Piceous, legs and elytra pale, the latter with darker discal cloud. Form and general characters of *discoideus* but more depressed and less shining. Length .36—.40 inch ; 9—10 mm.

The anterior and middle tarsi of the *male* are more broadly dilated, otherwise the sexual characters are as in *discoideus*.

I adopt or rather retain Say's name for this species in preference to the older one of Fabricius. I can see no advantage in respecting priority in a case of this kind, as the older name carries with it an erroneous locality.

Occurs nearly everywhere in the Atlantic region.

26. **A. pitychrous** Lec. Form of the preceding, but a little more convex, with the surface varying from violaceous to greenish, the general color piceous. Thorax similar in form to *baltimorensis* but less broad, a little more convex and usually less punctured at base. Elytra also similar in form but more parallel, the striæ fine, the intervals flat and at apex 2—4—6 are distinctly punctured. Body beneath and legs piceous. Length .34—.38 inch ; 8.5—9.5 mm.

Sexual characters as in *baltimorensis*.

Closely related to the next species, but differs in the punctuation of the elytral intervals and by the smooth head and absence of coarse punctures from the apex of the thorax.

Occurs from Colorado westward to California and Oregon.

27. **A. porosus** Motsch. Form of *baltimorensis*, piceous, surface with metallic lustre varying from violaceous to green. Head coarsely punctured above the eyes. Thorax usually coarsely punctured along the basal and apical margins, the hind angles rectangular, usually prominent. Elytra strongly sinuate at apex, the striæ fine, the alternate intervals usually more convex and impunctured, the flat intervals (2—4—6) punctured from base to apex. Length .36—.42 inch; 9—10.5 mm.

Sexual characters as in *baltimorensis*.

It will be observed in this species, that those forms in which the elytral intervals are decidedly alternating in convexity are females. The punctuation of the flatter intervals varies from very fine to rather coarse, while there are specimens in which the convex intervals are punctulate, but less than the flat ones. By this explanation it will be easy to account for the numerous synonyms.

In recently collected specimens the fine punctures of the flat intervals bear short hairs.

I have placed *Harpalus alternans* Motsch. as a probable synonym, and I would have adopted this name for the species had I been absolutely certain of the correctness of this course.

Occurs from New Mexico to Oregon, following the distribution already noticed in many other species.

C—a, *amaroides* Group.

Species slightly oval, *Amara*-like, surface glabrous and variously colored, usually with slight metallic lustre. Terminal spur of anterior tibiæ slender. Posterior tarsi variable. Elytra sinuate at tip, striate, dorsal puncture distinct.

Male. Anterior tarsi rather broadly dilated, the first four joints densely pubescent beneath. Middle tarsi less dilated, the first joint entirely glabrous in *coenus* or with slight pubescence at tip in the other two species, the next three joints pubescent beneath.

Female. Tarsi slender not pubescent beneath. Elytra less shining than the male.

There is but one setigerous puncture on each side of the clypeus in this group.

The species are as follows:

Posterior tarsi slender, the first joint fully equal to the next two. Metasternum at sides and intercoxal process smooth.

Thorax scarcely wider at base than apex. First joint of middle tarsus ♂ glabrous beneath. Species oblong.....28. **laetus** Dej.

Thorax broader at base, as wide as the elytra. First joint of middle tarsus ♂ pubescent at tip. Species oval..... .....29. **coenus** Say.

Posterior tarsi distinctly flattened, the first joint shorter than the next two. Metasternum at sides and intercoxal process punctate.

Sides of thorax behind nearly parallel, hind angles rectangular. Middle tarsus of male with first joint very slightly pubescent at tip,

30. **amaroides** Lec.

28. **A. laetus** Dej. Oblong, moderately elongate, parallel, piceous with aeneous metallic surface lustre, narrow margin of thorax and elytra and legs testaceous. Head smooth, clypeus with one setigerous puncture on each side. Thorax broader than long, sides regularly arcuate, hind angles distinct, base a little wider than apex, margin narrowly depressed and pale, disc slightly convex with few punctures near the base, basal impressions distinct but feeble. Elytra rather broadly striate, intervals flat, smooth, more shining in the male, apex feebly sinuate, side margin narrowly and epipleuræ pale. Body beneath smooth, shining, piceous, abdomen somewhat paler. Length .32—.34 inch ; 8—8.5 mm.

The *male* has the anterior tarsi rather broadly dilated, the first four joints pubescent beneath, the first at tip only, middle tarsi feebly dilated, the first joint with a small pubescent space at tip, the next three fully pubescent.

In the *female* the tarsi are all slender.

Occurs in southern New Jersey, Georgia and Texas.

29. **A. coenus** Say. Oval, form of *rusticus*, piceous, moderately shining, surface with feeble metallic lustre. Head smooth. Thorax broad, narrowed in front, sides moderately arcuate, hind angles rectangular, side margin very narrowly depressed in front, more widely posteriorly, disc moderately convex, basal impressions broad and shallow and sparsely punctulate. Elytra striate, intervals flat, smooth, more shining in the male, apex feebly sinuate, epipleuræ usually paler. Body beneath smooth, piceous. Femora piceous, tibiæ and tarsi paler. Length .32 inch ; 8 mm.

Sexual characters as in *laetus*, except that the first joint of middle tarsi of male is entirely glabrous beneath.

Occurs in the Middle States region.

30. **A. amaroides** Lec. Oblong oval, piceous, moderately shining, surface with feeble metallic lustre, violaceous to greenish. Head smooth. Thorax broader than long, narrower at apex, sides in front moderately arcuate, posteriorly straight, parallel, hind angles sharply rectangular, margin narrowly depressed, more widely posteriorly, disc moderately coarsely sparsely punctulate in front, more densely at base, basal impressions moderately deep. Elytra striate, intervals flat, smooth, more shining in the male, apex distinctly sinuate. Body beneath piceous. Intercoxal process and sides of metasternum punctate. Legs piceous. Length .36—.46 inch ; 9—11.5 mm.

The sexual characters are as in *laetus*, the first joint of middle tarsi ♂ having a very small trace of pubescence at tip.

Occurs in California in the central valley.

C—b, *sericeus* Group.

Species oblong, black, opaque, densely punctulate, finely pubescent. Terminal spur of anterior tibiæ slender. Posterior tarsi slender, nearly as long as the tibiæ, the first joint as long as the next two. Elytra sinuate at tip, striate but without distinct dorsal puncture.

Male. Anterior tarsi dilated, the first four joints densely pubescent beneath. Middle tarsi dilated, the first joint pubescent over its entire surface, the next three densely pubescent.

Female. Tarsi slender, not pubescent beneath.

The clypeus has but one setigerous puncture on each side.

One species occurs in our fauna :

Thorax as wide at base as apex, hind angles rounded, intervals of elytra alternately with coarser punctures, irregularly placed. Femora black, tibiæ and tarsi pale.....31. **sericeus** Harr.

31. **A. sericeus** Harris. Oblong, black, opaque. Head sparsely punctate. Antennæ rufous. Thorax broader than long, apex and base equal, sides regularly arcuate, hind angles rounded, disc feebly convex, surface sparsely punctate, more densely at base and near the sides. Elytra striate, intervals slightly convex, densely punctulate, each puncture with a short hair, apex sinuate, the alternate intervals with coarser obsolete punctures. Body beneath black, opaque. Femora piceous, tibiæ and tarsi pale. Length .40 inch ; 10 mm.

The anterior and middle tarsi of the *male* are dilated, the first four joints pubescent, the first joint over nearly its entire surface. In the female these tarsi are slender.

Canada and Middle States to Nebraska.

In addition to the species described in the foregoing pages the following has been described :

Dichirus pallidus Motsch. Elongatus, parallelus, pallidus ; capite, thorace elytrorumque medio infuscatis ; mandibulis robustis ; thorace subquadrato, postice angustato, angulis posticis obtusis ; elytris thorace duplo longioribus, striatis, interstitiis impunctatis ; pedibus ciliatis. Long 2¼ lin. —lat. 1 lin.

In addition the following characters are given :

There is no punctuation nor pubescence on the upper side of the body. The thorax is square, narrowed behind, the surface transversely rugulose. On each side of the base is a rounded shallow impression.

These characters seem to indicate that the species is not a *Dichirus* (group A—a) but that it is probably more closely allied to and possibly merely an immature form of *A. pitychrous* Lec.

It occurs in California.

Synonymy and Bibliography.

A. strenuus Horn, *Trans. Am. Ent. Soc., 1868, p. 130.

A. dilatatus Dej., Species iv, p. 241.
hirsutus Men., Bull. Ac. Petrop., ii, 1844, p. 61.

A. obtusus Lec.,* Ann. Lyc., v, p. 185.

A. pilosus, n. sp.*

A. immanis, n. sp.*

A. brunneus Dej.,* Species iv, p. 239.

A. piceus* Men., Bull. Acad. Petrop., ii, 1844, p. 61.
brunneus ‡ Mann., Bull. Mosc., 1843, ii, p. 212.
villosus Mots., Bull. Mosc., 1845, iv, p. 344.
irregularis Mots., loc. cit., p. 345.
parallelus Lec.,* Ann. Lyc., v, p. 184.

A. harpaloides Ferté, Ann. Ent. Soc. Fr., 1841, p. 208.

A. dulcicollis Ferté,* Rev. Zool., 1841, p. 44.
ellipticus Lec.,* Ann. Lyc., iv, p. 284.

A. opaculus Lec.,* New Species, 1863, p. 16.
elongatus Chaud.,* Rev. Mag. Zool., 1868, p. 13.

A. rusticus Say, Trans. Am. Phil. Soc., ii, p. 32; Lec. Ann. Lyc. iv, p. 284.
tristis Dej., Species iv, p. 158.
merula Germ., Ins. spec. nov., p. 24; Dej. Species, iv, p. 155.
pinguis Lec.,* Ann. Lyc., iv, p. 282.
crassus Lec.,* loc. cit., p. 282.
gravidus Lec.,* loc. cit., p. 283.
haplomus Chaud.,* Rev. Mag. Zool., 1868, p. 13.

A. carbonarius Say, Trans. Am. Philos. Soc., ii, p. 32.
luctuosus Dej., Species iv, p. 151.
rufipennis Lec.,* Ann. Lyc., iv, p. 281.

A. furvus Lec.,* New Species, 1863, p. 14.

A. semipunctatus Lec.,* Proc. Acad., 1859, p. 83.
similis Lec.,* Ann. Lyc., v, p. 183.
puncticollis Chaud.,* Rev. Mag. Zool., 1868, p. 11.

A. consobrinus Lec.,* Ann. Lyc., v, p. 183.
brevicollis Lec.,* loc. cit.

A. californicus Dej.,* Species iv, p. 148.
confusus Lec.,* Ann. Lyc., v, p. 183.

A. interpunctatus Kby., Fauna. Bor. Am., iv, p. 42, pl. 7, fig 8.
nigrita ‡ Lec.,* Ann. Lyc., iv, p. 279; New Species, 1863, p. 15.
Lecontei ‖ Chaud., Rev. Mag. Zool., 1868, p. 11.

A. agricola Say., Trans. Am. Philos. Soc., ii, p. 33.
paradoxus Hald.,* Proc. Acad., i, p. 302.
striatus Lec.,* Ann. Lyc., iv, p. 280.

A. Harrisii Lec.,* New Species, 1863, p. 14.

A. nigerrimus Dej.,* Species v, p. 842.
laticollis Kby., Fauna Bor. Am., iv, p. 43.
punctulatus Lec.,* New Species, 1863, p. 14.

A. nigrita Dej.,* Species, iv, p. 149.
interpunctatus ‡ Lec.,* Ann. Lyc., iv, p. 279.

A. melanopus Hald.,* Proc. Acad., i, p. 302.
agricola ‡ Lec.,* Ann. Lyc., iv, p. 279.

A. nivalis, n. sp.*

A. discoideus Dej.,* Species v, p. 831.

A. baltimorensis Say, Trans. Am. Philos. Soc., ii, p. 33; Dej. Sp. iv, p. 153.
Sanctæ-Crucis Fab., Ent. Syst. Suppl., p. 58; Schaum. Stett. Zeits., 1847, p. 47.

A. pitychrous Lec.,* Proc. Acad., 1861, p. 339.

A. porosus Motsch., Bull. Mosc., 1845, iv, p. 344.
sublævis Motsch.,* Bull. Mosc., 1859, iii, p. 138.
chalceus Lec.,* Col., Kansas, 1859, p. 2.
alternans Lec.,* Ann. Lyc., v, p. 184.
viridescens Lec.,* Proc. Acad., 1861, p. 339.
rudis Lec.,* New Species, 1863, p. 15.
Lecontei Harold, Catalogus, p. 256.
? alternans Mots. (*Harpalus*), Bull. Mosc., 1845, iv, p. 343.

A. laetus Dej.,* Species, iv, p. 154.

A. coenus Say, Trans. Am. Philos. Soc., ii, p. 34; Dej. Species, iv, p. 158.
subæneus Lec.,* Ann. Lyc., iv, p. 285.
obscurus Lec.,* loc. cit., p. 286.

A. amaroides Lec.,* Ann. Lyc., v, p. 184.

A. sericeus Harr.,* N. E. Farmer, 1828, p. 177.
femoratus Dej., Species, iv, p. 224.

A. (*Dichirus*) **pallidus** Mots., Bull. Mosc., 1859, iii, p. 137. Unknown to me.

Species marked * are those of which I have studied the type or a specimen carefully compared therewith.

Critical notes on the Species of SELENOPHORUS *of the United States.* *By George H. Horn, M. D.*

(*Read before the American Philosophical Society, Nov. 5th,* 1880.)

Without wishing at the present time to discuss the question of the validity of Selenophorus as a genus distinct from Harpalus, I will only state that no characters have yet been given which are permanent in all the species. Nevertheless it seems to be at least a well defined group in which there are three series of punctures or foveolæ situated on the second, fifth and seventh elytral striæ, a character which suggests a similar division of species in Pterostichus.

The only work in which the species of this genus has been treated as a whole is by M. Putzeys (Stettin Zeitschrift, 1878, pp. 1—73), whose arrangement, even with our small number of species, I have been unable to follow, the primary division being rather inexact and the secondary characters not easy to be perceived. There seems also to have been a tendency to exaggerate the importance of differences which are either individual or local and the number of species unnecessarily increased.

Since the reception of the above mentioned paper, material has gradually been accumulated in our cabinets from all parts of the country, which shows clearly that the species have a very wide range of distribution, and the variations between widely separated localities are well marked, while the differences become evanescent in intermediate localities.

All the species belong to the Atlantic fauna, several however extend through Arizona to the Peninsula of California, but none occur in the true Pacific fauna, that is from San Diego northward.

The following table gives in brief the characters separating the species recognized in the subsequent pages :

Prosternum obtuse at tip, not margined.
  Species with bronzed surface lustre.
    Intervals of elytra smooth, not pubescent, eighth stria not distant from margin.
      Elytra at tip feebly sinuate, the outer interval punctulate.
        Elytral punctures large, almost foveolate.....**palliatus** Fab.
        Elytral punctures very small.....**pedicularius** Dej.
      Elytra at tip strongly sinuate, the outer angle subdentate.
        Outer interval not punctulate.....**fatuus** Lec.
    Intervals punctulate and pubescent, eighth stria more distant from the margin than from the seventh.....**breviusculus**, n. sp.
  Species black above, more or less iridescent.
    Thorax as wide or wider at base than apex.
      Outer interval punctulate.....**opalinus** Lec.
      Outer interval not punctulate.....**gagatinus** Dej.
    Thorax distinctly narrowed at base.
      Hind angles obtuse.
        Marginal interval punctulate.....**iripennis** Say.
      Hind angles rectangular and prominent..... **subtinctus** Lec.
Prosternum horizontal, tip slightly prolonged and margined.
  Thorax not broader at base than apex.
    Form rather narrow, elytral punctures foveolate.....**fossulatus** Dej.
    Form broader, elytral punctures small..... ..... **ovalis** Dej.
  Thorax broader at base than apex, sides nearly regularly arcuate from base to apex..... .....**ellipticus** Dej.

The characters above given seem sufficiently plain to need no comment. There have been no differences observed in the clypeal setigerous punctures, all the species having but one puncture on each side. The males have the anterior and middle tarsi moderately dilated, with two series of squamiform papillæ on the first four joints.

S. palliatus Fabr. Piceous, legs pale, upper surface shining, bronzed. Thorax equally wide at base and apex, sides feebly arcuate in front, hind angles distinct, nearly rectangular but not prominent, basal impressions moderate and with very few punctures. Elytra a little wider than the thorax, oblong oval, very feebly sinuate at tip, finely striate, striæ 2—5—7 each, with rather large punctures, the marginal interval finely punctulate and pubescent. Length .28—.32 inch; 7—8 mm.

With this species I unite *laesus* Lec., which differs only in having the dorsal punctures a little smaller. It is the largest species of the bronzed series in our fauna.

Occurs from Florida to the Peninsula of California.

S. pedicularius Dej. Oblong oval, piceous, shining, surface bronzed, legs pale. Thorax a little broader at base than apex, sides arcuate, hind angles obtuse, disc moderately convex, basal impressions almost entirely obliterated. Elytra scarcely wider than the thorax, finely striate, intervals flat, smooth, the marginal finely punctulate, striæ 2—5—7 with fine punctures, apex feebly sinuate. Length .20—.26 inch; 5—6.5 mm.

With this species I unite *troglodytes, aereus* and *puellus*. It is possible in a large series, such as I have now before me, to select forms which will agree in every particular with the descriptions of Dejean and Putzeys, but they are not species and do not deserve the name of varieties. *S. troglodytes* is more convex and the sides of the thorax a little more arcuate, the vast majority of these are females. The marginal punctation is said by Putzeys to be without pubescence; this is not true in any well preserved specimen. The description of *puellus* shows no character whatever of a specific nature. The *aereus* Lec. is placed by Putzeys in another series in which the tarsi are said to be long, but after a careful study of this character, I find it entirely deceptive and not of the value already observed in Anisodactylus. The posterior tarsi in all the bronzed species are somewhat broader than in the iridescent species, but their length as compared with the tibiæ is the same.

I cannot understand why Putzeys, after placing *puellus* next after *pedicularius* (12) and *troglodytes* (13) in the table, should place it as 55 near *aereus* (56) in the text.

Occurs from the Middle States to Kansas, Florida and Arizona.

S. fatuus Lec. Closely resembles the preceding but more slender in form. The thorax is less transverse, somewhat narrowed behind, the hind angles distinct. The elytra are similarly sculptured but the marginal interval is entirely impunctulate and consequently not pubescent, the apex is strongly sinuate, the outer angle of the sinuation quite prominent. Length .20—.24 inch; 5—6 mm.

This species is usually darker in color than *pedicularius* and more shining.

In this species Zimmerman (Trans. Am. Ent. Soc., 1869, p, 247,) recognized *parumpunctatus* Dej., and from the comparisons made by Putzeys, I am inclined to think that view correct, but not having types of Dejean's species, cannot say so definitely.

Occurs in the Gulf States.

S. breviusculus, n. sp. Oval, slightly oblong, facies robust, piceous, legs pale, surface feebly shining with distinct bronze lustre. Head punctulate, rugulose at the sides above the eyes. Thorax broad, apex and base equal, sides rather strongly arcuate, basal angles broadly rounded, base feebly emarginate at middle, disc convex, sides slightly depressed posteriorly, at middle more shining, finely transversely wrinkled, in front finely punctulate, at base and sides densely punctate and opaque. Elytra not wider than the thorax, scarcely one-third longer than wide, sides moderately arcuate, apex scarcely at all sinuate, moderately deeply but finely striate, intervals flat and irregularly but finely biseriately punctulate and pubescent, serial punctures very fine and indistinct, eighth stria distant from the margin. Body beneath feebly shining, abdomen sparsely punctate and with short pubescence. Legs testaceous, middle and posterior tibiæ slightly arcuate. Length .26 inch ; 6.5 mm.

This species is evidently allied to *crassiusculus*, *curvipes* and *arcuatus*, which Putzeys unfortunately omits from his synoptic table. It is very distinct from any other in our fauna in its general aspect as well as by the characters above given.

One specimen in my cabinet from Fort Cobb, Indian Territory, collected by Dr. Edw. Palmer, another in Mr. Ulke's cabinet.

S. opalinus Lec. Oblong, black, surface rather brilliantly iridescent. Head smooth, a foveate puncture more or less distinct on each side of the vertex. Thorax broader than long, base as wide as apex or a little wider, sides feebly arcuate, margin narrowly depressed and translucent, disc feebly convex, surface sparsely indistinctly punctulate along the base, hind angles distinct but obtuse. Elytra a little wider than the thorax, sides parallel ♂ or slightly arcuate ♀, apex feebly sinuate, surface rather deeply striate, intervals slightly convex, more so at apex and sparsely indistinctly punctulate, serial punctures distinct but not large, outer interval very distinctly punctate but not pubescent. Body beneath shining, abdomen sparsely indistinctly punctulate. Legs rufo-testaceous. Length .36—.40 inch ; 9—10 mm.

This is our largest species of the iridescent series.

Occurs from Wisconsin and Michigan to Florida and thence westward to the Peninsula of California.

S. gagatinus Dej. More slender and parallel than *opalinus* as well as more convex. The surface is also less iridescent, the thoracic margin extremely narrow and not translucent. The punctures of the elytral intervals are scarcely visible, while the marginal interval is absolutely smooth. Femora piceous, tibiæ and tarsi paler. Length .30 inch ; 7.5 mm.

To this species I refer some specimens collected by me in early Spring in Arizona which are probably immature. The head and thorax are rufo-piceous and the elytra more finely striate than in the normal form. I am unwilling to separate them until more mature specimens are seen.

Putzeys states in error that the prosternum is margined in this species.

Occurs from Massachusetts to Texas.

S. iripennis Say. Thorax broader than long, very distinctly narrowed posteriorly, hind angles distinct but obtuse, margin narrow and slightly translucent, disc smooth with few fine punctures in the vague basal impressions. Elytra broader than the thorax, sides feebly arcuate, apex scarcely sinuate, surface striate, striæ obsoletely finely punctulate, intervals flat, very obsoletely finely punctulate, the marginal usually distinctly punctulate. Legs testaceous. Length .26 inch ; 6.5 mm.

The narrowing of the thorax behind in this species is quite well marked, so that it resembles in form certain Bradycellus.

Occurs from Illinois to Georgia and Texas.

In the synoptic table given by Putzeys, *opalinus* and *gagtinus* are placed in a series in which the thorax is said to be "narrowed behind without prominent angles," while in the description the former is said to have a square thorax equally narrowed at apex and base, while the latter is said to be narrowed in front. They are also widely separated in the body of his paper with thirty-one species between.

S. subtinctus Lec. Closely resembles *iripennis*, but the thorax is more narrowed posteriorly and the hind angles sharply rectangular and slightly prominent. The outer elytral interval is very narrow and smooth. Legs pale rufo-testaceous. Length .24 inch ; 6 mm.

One specimen ; Louisiana.

S. fossulatus Dej. Oblong, depressed, black, surface with silken lustre. Thorax broader than long, base and apex equal, or the former slightly narrower, sides regularly arcuate, hind angles rectangular, not prominent. Elytra very little wider than the thorax, sides feebly arcuate, striæ very fine, serial punctures large and foveolate, apex feebly sinuate. Body beneath and legs piceous, shining, tibiæ and tarsi usually paler. Length .24 inch ; 6 mm.

This species is the least oval of this group and is easily known by the thorax, elytral punctures and lustre.

Occurs in Georgia and Florida.

S. ovalis Dej. Oblong oval, depressed, black, subopaque. Thorax with the base and apex nearly equal or very little broader at base, sides regularly arcuate, hind angles rectangular, not prominent. Elytra a little broader at base than the base of the thorax, sides moderately arcuate, apex very feebly sinuate, surface finely striate, intervals flat, serial punctures moderate in size. Body beneath and legs piceous, surface slightly iridescent. Length .28 inch ; 7 mm.

Occurs in Georgia and Florida.

S. ellipticus Dej. Oblong oval or elliptical, black, subopaque. Thorax wider at base than apex, sides regularly arcuate, hind angles rectangular. Elytra not wider than base of thorax, the margins of each nearly continuous, surface finely striate, intervals flat or very slightly convex, serial punctures very small, apex scarcely at all sinuate. Body beneath black, shining. Legs rufo-testaceous. Length .20—.24 inch ; 5—6 mm.

The males are a little more shining than the females. With this species I unite *granarius* Dej. The larger number of the species have the thorax regularly narrowing from base to apex, some few however have the base a little narrower than the disc, a little in front of the base, but the transition from one form to the other is very gradual.

Occurs from the Middle States to Georgia and Texas.

The three preceding species have the prosternum horizontal at tip, slightly prolonged and distinctly margined at the sides and apex. They form a very natural group.

SYNONYMY AND BIBLIOGRAPHY.

S. palliatus Fab., Ent. Syst. Suppl., p. 58.
stigmosus Germ., Ins. Spec. nov., p. 35 ; Putz. Stett. Zeits., 1878, p. 13.
impressus Dej., Spec., iv, p. 82 ; Ic., pl. 175, fig. 5.
laesus Lec., Proc. Acad., 1858, p. 59.

S. pedicularius Dej., Spec., iv, p. 100 ; Putz., loc. cit., p. 18.
troglodytes Dej., ibid., p. 101 ; Putz., p. 18.
aereus Lec., Ann. Lyc., iv, p. 293.
planipennis Lec., ibid., p. 294.

S. fatuus Lec., New Species, 1863, p. 17.
excisus ‖ Lec., Proc. Am. Philos. Soc., 1878, p. 377.

S. breviusculus Horn, n. sp.

S. subtinctus Lec., Proc. Acad., 1866, p. 365.

S. iripennis Say, Trans. Am. Philos. Soc., ii, p. 30.
varicolor Lec., Ann. Lyc., iv, p. 292.

S. gagatinus Dej., Spec., iv, p. 112; Putz., loc. cit., p. 43.
maurus Hald., Proc. Acad., i, p. 306.
viridescens Lec., Ann. Lyc., iv, p. 292.

S. opalinus Lec., List. Col., N. A., p. 13 ; Putz., loc. cit., p. 52.
iripennis ‡ Lec., Ann. Lyc., iv, p. 289.

S. fossulatus Dej., ibid., p. 88 ; Putz., loc. cit., p. 15.

S. ovalis Dej., Spec., iv, p. 106 ; Putz., loc. cit., p. 20.

S. ellipticus Dej., ibid., p. 108 ; Putz., loc. cit., p. 20.
granarius Dej., ibid., p. 109 ; ibid., p. 21.
pulicarius Dej., ibid., p. 108.

List of Papers Communicated to the American Philosophical Society.

By Pliny Earle Chase, LL.D.

(*Read before the American Philosophical Society, November* 5, 1880.)

1. Sanscrit and English Roots and Analogues. Sept. 17, 1858, *P.** vii, 177–91.
2. Chinese and Indo-European Roots and Analogues. Jan. 18, 1861, *P.* viii, 5–48.
3. Intellectual Symbolism. Oct. 3, 1862, *T.** xii, 463–504.
4. Chinese Seal Inscriptions. Feb. 6, 1863, *P.* ix, 139.
5. Chinese Analogues in other languages. Feb. 20 to May 15, 1863, *P.* ix, 145, 172, 231.
6. Catalogue of Trade Tokens circulating during the war of the Rebellion. Sept. 18, 1863, *P.* ix, 242–58.
7. Mathematical Probability of Accidental Linguistic Resemblances. Sept. 18, 1863, *T.* xiii, 25–33.
8. Comparative Etymology of the Yoruba Language. Sept. 18, 1863, *T.* xiii, 35–68.
9. Note on Possible Vowel Sounds not used in any Language. Oct. 2, 1863, *P.* ix, 271.
10. On the Diurnal Variations of the Barometer; elastic actions and reactions proportioned to mass; cyclical motions in a resisting medium, furnishing *harmonic indications of Sun's mass and distance;* anticipation of astronomical verifications or rectifications by means of varying pressures; *importance of the fundamental equations,* $v = \frac{gt}{2}$; $h = \frac{gt^2}{4}$; in which t represents the time of cosmical, molecular, or atomic rotation, and g represents the acceleration of a central force. Dec. 18, 1863, *P.* ix, 283–8 (Maxwell, Edlund, Crookes, Lockyer).†

The above was the first of a series of physical papers in confirmation of the following *General Postulate. All physical phenomena are due to an Omnipresent Power, acting in ways which may be represented by harmonic or cyclical undulations in an elastic medium.*

11. On the Height of the Tides; principles of (10) applied to the explanation of some tidal anomalies. Jan. 1, 1864, *P.* ix, 291–4.
12. Daily Distribution of Heat; coördinate thermodynamic influences of solar radiation, cyclical elasticity, and barometric pressure. March 4, 1864., *P.* ix, 345–9.
13. Mechanical modification of electric and other elastic currents; gravity, electricity and terrestrial magnetism regarded as "modes of motion" (Gray, Edison, Bell, Channing, Crookes); illustrations of the

* *P., Proceedings; T., Transactions.*

† The names in parentheses are those of subsequent investigators, whose researches have confirmed the conclusions of the papers.

hypothesis that electricity consists simply of æthereal vibrations (Maxwell, Edlund). April 1, 1864, *P.* ix, 355–60.

14. Polarizing influences of thermal convection and radiation ; correspondence between Challis's laws of molecular action and the laws of attraction and rotation (Baumhauer, Meyer, Mendelejeff, Zaengerle). April 15, 1864, *P.* ix, 367–71.
15. Lunar-monthly barometric variations ; resemblances to daily barometric fluctuations. June 17, 1864, *P.* ix, 395–9. Also, Proc. Roy. Soc. June 16, 1864, xiii, 329–333.
16. Component elements of normal barometric tides ; influence of oscillations moving with the velocity of light. July 15, 1864, *P.* ix, 405–11.
17. Comparative fitness of languages for musical expression. Sept. 16, 1864, *P.* ix, 419–20.
18. Primitive names of the Supreme Being. Sept. 16, 1864, *P.* ix. 420–4.
19. Numerical Relations of Gravity and Magnetism ; Formulation of Hypothesis of Unity of Elastic Force ; Kinetic Ratio of Sound Waves to Light Waves (Edlund, Mendelejeff, Crookes, Lockyer, Edison). Oct. 21, 1864, *P.* ix, 425–40 ; *T.* xiii, 117–36.
20. Comparison of Solar and Lunar Magnetic and Aerial Tides ; Magellanic medal awarded Dec. 16, 1864 (Maxwell, 1873). *P.* ix, 487–95.
21. Radical Significance of Numerals. Feb. 17, 1865, *P.* x, 19–23.
22. Copto-Egyptian Vocabulary. April 7, 1865, *P.* x, 69–94.
23. Relations of Magnetic Declination to Gravity ; Heat and Attraction ; Different manifestations of the Force which controls Stellar-Systems as well as Molecular Motions. April 21, 1865, *P.* x, 97–104.
24. Relations of Magnetic Inclination to Gravity ; Accomplishment of Faraday's Desideratum. May 19, 1865, *P.* x, 111–8.
25. Experiments in Mechanical Polarization of magnetic needles by vibrations resembling those of Terrestrial convection and atmospheric currents ; mechanical polarization of Sky Light. Oct. 6, 1865, *P.* x, 151–66.
26. Observations on Skylight polarization at Philadelphia ; Remarkable visibility of all the neutral Points. Jan. 5, 1866, *P.* x, 196–7.
27. Comparative visibility of Arago's, Babinet's, and Brewster's Neutral Points, in Philadelphia and its neighborhood. April 6, 1866, *P.* x, 223.
28. Relations of Temperature to Gravity and Density ; General Equation of Oscillation and Parabolic motion ; Thermodynamic *vis viva;* Comparative Energy of action and reaction at the source of Solar Radiation and at Earth's Orbit : simple harmonic relation between terrestrial gravity and the velocity of light. Sept. 21, 1866, *P.* x, 261–9.
29. Laws regulating the distribution and transmission of Solar heat. Feb. 1, 1867, *P.* x, 309–15.
30. Probabilities in etymology ; a reply to criticism. Sept. 20, 1867, *P.* x, 345–9.

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31. Meteor seen at Haverford College. Oct. 4, 1867, *P.* x, 353.
32. Meteors of Nov. 13, 14, 1867. Nov. 15, 1867, *P.* x, 357.
33. Specific Magnetism of iron; cosmical and molecular comparisons. Nov, 15, 1867, *P.* x, 358.
34. General connotations of magnetism; accordance between barometric and astronomical estimates of Sun's distance. Feb. 21, 1868, *P.* x, 368–79.
35. Evidences of Lunar influence on rainfall. June 19, 1868, *P.* x, 436–9.
36. Tidal Rainfall of Philadelphia; similarity of influence in different independent periods. Dec. 4, 1868, *P.* x, 523–37.
37. Meteors of Nov. 13, 14, 1868. Dec. 4, 1868, *P.* x, 539.
38. Philadelphia Life Tables. Feb. 5, 1869, *P.* xi, 17–22.
39. Cosmical relations of light to gravity; influence of the *modulus* of light, velocity, mass, distance, centres of gyration, orbital eccentricity, inertia, and ratio of circumference to diameter on cosmical and molecular phenomena (Alexander, 1877); solar centripetal reaction against the action of gravity towards the centre of the solar system gives *the velocity of light* in the fundamental equation $v = \frac{gt}{2}$. April 2, 1869, *P.* xi, 103–7.
40. Comparison of rainfall at Greenwich and Philadelphia; cosmical and local influences upon meteorology. May 7, 1869, *P.* xi, 113.
41. Tidal Rainfall; comparison of lunar influences at Providence, Chiswick and Toronto. Oct. 1, 1869, *P.* xi, 203.
42. Comparison of mechanical Equivalents. Jan. 7, 1870, *P.* xi, 313.
43. Monthly variations of rainfall at Philadelphia. Feb. 4, 1870, *P.* xi, 314–5.
44. European and American rainfall; comparison of quarterly rains at Philadelphia and Lisbon. March 3, 1871, *P.* xii, 38–9.
45. American Weather Notes; local influences; importance of gradients; frequency of anticyclonic storms; local cyclones in general anticyclones (Signal Service). March 3, 1871, *P.* xii, 40.
46. Winds of the United States; General anticyclonism; storm centres at normal intersections of prevailing currents. March 17, 1871, *P.* xii, 65–7.
47. Resemblance of atmospheric, magnetic and oceanic currents; primary coördinate great circles; uniform evidences of gravitating influence. April 7, 1871, *P.* xii, 68–70.
48. Relation of Auroras to gravitating currents. May 5, 1871, *P.* xii, 121–2.
49. Winds of Europe. June 16, 1871, *P.* xii, 123.
50. Normal position of the tidal ellipsoid. June 16, 1871, *P.* xii, 123–4.
51. Cyclical Rainfalls at Lisbon; solar and lunar influences compared at different independent periods; blending tidal currents of different temperatures and different degrees of humidity. Aug. 18, 1871, *P.* xii, 178–90.
52. Correlations of cosmical and molecular force; harmonic estimates of solar mass and distance from the explosive energy of oxygen and hy-

drogen (Young); *vis viva* of wave propagation = ½ of the ***vis viva*** of oscillating particles (Maxwell, 1877). Feb. 16, 1872, *P.* xii, 392–4.

53. The Herschel-Stephenson Postulate; conditions of stability in elastic atmospheres; influences of centres of oscillation on planetary masses, distances, and times of rotation. March 1, 1872, *P.* xii, 395–7.
54. Further approximations to sun's distance; accordant harmonies of terrestrial rotation, lunar distance, lunar revolution, explosive energy, and the velocity of light. April 5, 1872, *P.* xii, 398–400.
55. General relation of Auroras to Rainfall. April 5, 1872, *P.* xii, 400.
56. Influence of meteoric showers on Auroras. May 16, 1872, *P.* xii, 401–3.
57. Planetary Illustrations of Explosive Oscillation; apsidal and mean positions and eccentricities (Alexander, 1877). May 16, 1872, *P.* xii, 403–5.
58. Undulatory harmonies of solar and planetary rotation, revolution, mass, gravity, and light. May 16, 1872, *P.* xii, 406–7.
59. Aethereal density and polarity; influences on cosmical masses and relative positions. May 16, 1872, *P.* xii, 407–10.
60. The sun-spot cycle of 11.07 years; wave-cycle of Jupiter's projectile locus (mean perihelion distance). May 16, 1872, *P.* xii, 410–1.
61. Aethereal Oscillation, the primordial material Force; cardinal centres of wave influence; planetary illustrations. July 5, 1872, *P.* xii, 411–7.
62. Daily auroral and meteoric means. Sept. 20, 1872, *P.* xii, 516–8.
63. Stellar and Planetary Correlations; relations of distance to cardinal points of explosive oscillation; rupturing velocities acquired by nebular "subsidence" from nd to $\frac{nd}{n+1}$; evidences of parabolic projection between *a Centauri* and sun, *the locus of the paraboloid being determined by the solar modulus of light, sun's linear centre of oscillation, and sun's gravitating reaction against luminous undulation;* harmonic positions of loci of planetary rupturing velocities. *These are the only* POSITIVE *evidences yet discovered of gravitating influence between different stellar systems.* Sept. 20, 1872, *P.* xii, 518–22.
64. Cyclical rainfall at San Francisco; indications of planetary as well as lunar influence. July 19, 1872, *P.* xii, 523–42.
65. Recent monthly Rainfall in the United States; compiled from Signal Service reports; lunar influence less disguised than solar. Nov. 1, 1872, *P.* xii, 555–7.
66. Lunar-cyclical Rainfall in the northern Temperate Zone. Nov. 1, 1872, *P.* xii, 558–9.
67. Oscillatory Forces in the Solar system; harmonies of apsidal and mean planetary positions and moments of inertia; influence of the ratio of the circumference to the diameter of a circle (Forbes, 1880). Feb. 7, 1873, *P.* xiii, 140–1.
68. Estimate of solar mass and distance from the equilibrium of elastic and gravitating forces. Feb. 7, 1873, *P.* xiii, 142–3.

69. Note on Planeto-Taxis; reasons for limitations of "Bode's law." March 7, 1873, *P.* xiii, 143–4.
70. Rotation of the sun and the Intra-asteroidal Planets. March 7, 1873, *P.* xiii, 145–7.
71. Planetary relations to the sun-spot period. March 7, 1873, *P.* xiii, 147–8.
72. Relative velocities of light and gravity. March 7, 1873, *P.* xiii, 148–9.
73. The gamuts of sound and light; correspondence of wave-length of the musical note, C_{23}, with that of the Fraunhofer C line; approximations in other wave-lengths of the two gamuts; comparative harmonic estimates of solar mass and distance; indications of a magnetic gamut, four octaves below that of light. March 21, 1873, *P.* xiii, 149–54.
74. The music of the spheres; apsidal and mean relations to musical intervals. April 4, 1873, *P.* xiii, 193–8.
75. Harmonic Indications of Intra-Mercurial planets; influence of Neptune, Jupiter and Sun in establishing harmonic nodes of planetary aggregation; *prediction of an "unknown planet or other seat of solar and planetary perturbation"* (De la Rue, Stewart and Loewy, Watson, Mouchez, Oppolzer, and others). May 2, 1873, *P.* xiii, 237–9.
76. Correlations of Planetary mass. May 16, 1873, *P.* xiii, 239–43.
77. Harmonies of Cosmical Rotation. May 16, 1873, *P.* xiii, 243–8.
78. Weather Study; confirmation of views (45, 46) by observations of signal service bureau. May 16, 1873, *P.* xiii, 248–52.
79. The Planetary node between Mercury and Vulcan. May 16, 1873, *P.* xiii, 252.
80. Recent Confirmation of an Astronomical Prediction. Oct. 3, 1873, *P.* xiii, 470.
81. Comparison of Planetary Series; harmonic series the closest of all. Oct. 3, 1873, *P.* xiii, 471–7.
82. Transcript of a curious MS. work in cypher, supposed to be astrological. Oct. 3. 1873, *P.* xiii, 477–82.
83. Origin of Attractive Force. Feb. 6, 1874, *P.* xiv, 111–4.
84. Saving Fund Life Insurance. April 3, 1874, *P.* xiv, 148–9.
85. Cosmical Thermodynamics; fifty postulates of unitary force, with references to illustrative papers. April 17, 1874, *P.* xiv, 141–7.
86. Cosmical evolution; relations of mean proportionality to time, mass, density, and the velocity of light. May 15, 1874, *P.* xiv, 159–61.
87. Jupiter-cyclical Rainfall. June 19, 1874, *P.* xiv, 193–5.
88. Cyclical rainfall at Barbados. June 19, 1874, *P.* xiv, 195–216.
89. Gravitating Waves; important nodal positions of Sun, Earth and Jupiter. Jan. 1, 1875, *P.* xiv, 344–6.
90. Lunar monthly Rainfall in the United States, from observations of the Signal Service Bureau. April 16, 1875, *P.* xiv, 416–8.
91. Further Relations of Magnetic, Gravitating and Luminous Force; analogous equations in general physics, electricity, chemistry, and

cosmogony; consequent estimate of Sun's mass, from Maxwell's magnetic data. June 18, 1875, *P.* xiv, 607–9.

92. Planetary Illustrations of the Creative Fiat. Aug. 20, 1875, *P.* xiv, 609–12.

93. Yearly rainfall in the United States, from observations of the Signal Service Bureau. Aug. 20, 1875, *P.* xiv, 613–4.

94. The Beginnings of Development; planetary linkages; *the velocity of light is the limit between the living forces of association and dissociation;* variety of rhythmical relations; successive steps of nebular condensation. Sept. 17, 1875, *P.* xiv, 622–31.

95. Further Dynamic Coördinations; *mathematical deduction of the ratio between the mean vis viva of gaseous volume (heat under constant volume) and the vis viva of uniform velocity (heat under constant pressure)*; harmonies of products and powers of mass and distance. Dec. 3, 1875, *P.* xiv, 651–8.

96. Nebular action in the solar system; confirmations of Herschel's theory of "subsidence;" electrical conductivity of selenium, illustrating the ratio of velocities between solar waves originating at Sun's surface and in Earth's orbit (Bell, Tainter). April 21, 1876, *P.* xvi, 184–92.

97. On some fundamental propositions of central force; nucleal radius varying as the $\frac{3}{4}$ power of the atmospheric radius; oscillatory formulas of cyclical motion; views of various investigators; universal correlations. July 21, 1876, *P.* xvi, 298–310.

98. Aethereal influences in the solar system; evidence of 58 accordances. Jan. 5, 1877, *P.* xvi, 496–505.

99. Chemical atoms, molecules and volumes; laws of Boyle, Charles, and Avogadro. Feb. 2, 1877, *P.* xvi, 505–8.

100. Further illustrations of central force; increase of velocity through "subsidence" should produce rupture in the periphery of a stationary nebula at $\frac{r}{n}$ when $n = 2 \div (3 - 2\sqrt{2})$; this influence shown by various planetary belts and positions; "subsidence" tending to form confocal elliptic orbits, with major axes of $\frac{3r}{2}$ and minor axes $\sqrt{2}\ r$, and belts, on account of collision, at $\frac{2r}{3}$; influence of the modulus of light and various ratios in positing planetary belts. July 20, 1877, *P.* xvii, 98–100.

101. Harmonies of solar spectrum; identity of law in luminous and planetary nodes. August 24, 1877, *P.* xvii, 109–12.

102. Results of wave interference; symmetrical formula, introducing masses of Sun and Jupiter, Sun's equatorial radius, Jupiter's projectile radius, and the velocity of light; significance of Earth's position and density; cosmical and molecular wave lengths: confirmation of "subsidence" and of harmonic undulations, by the moons of Earth, Mars, Jupiter, Saturn, and Uranus; *Alexander's adoption and confir-*

mation of my harmonic predictions. Jan. 18, 1878, *P.* xvii, 294–307.

103. Criteria of the Nebular Hypothesis. March 1, 1878, *P.* xvii, 341–5.

104. Radiation and rotation; explanation of Kirkwood's analogy; belts of planetary pairs. June 21, 1878, *P.* xvii, 701–4.

105. Crucial Harmonies; nine confirmations of prediction. Oct. 4, 1878, *P.* xviii, 34–6.

106. The limiting constant of gravitation; new method of identifying the velocity of light with gravitating force. Oct. 18, 1878, *P.* xviii, 41–3.

107. The Philosophy of Christianity. Feb. 7, 1879, *P.* xviii, 129–53.

108. Further confirmations of prediction; two additional evidences of harmonic solar disturbance. Feb. 21, 1879, *P.* xviii, 209.

109. Harmonies of Lockyer's "Basic Lines;" the fundamental wave-length representing a centre of spherical gyration, in Earth's reaction against solar action; the other lines all harmonic. April 4, 1879, *P.* xviii, 224–6.

110. Spectral estimates of Sun's distance. April 4, 1879. *P.* xviii, 227–9.

111. Correlations of mass; equations between masses of Sun and four outer planets; centres of various nebular influences. April 4, 1879, *P.* xviii, 229–32.

112. Approximate quadrature of the circle. June 20, 1879, *P.* xviii, 281.

113. Apparent semi-diameter of the Sun, and nebular origin of the terrestrial day. Dec. 19, 1879, *P.* xviii, 380–1.

114. Velocity of light and Kirkwood's analogy; *five estimates of the velocity of light based on the Nebular Hypothesis.* Jan. 2, 1880, *P.* xviii, 425–9.

115. Controlling centres; various estimates of mass and distance according to the Nebular Hypothesis. Jan. 2, 1880, *P.* xviii, 429–34.

116. Nodal estimate of the velocity of light. March 19, 1880, *P.* xviii, 4–9.

117. Cometary Paraboloids; comparison of planetary positions as determined by inter-stellar action, with M. Gaussin's geometrical approximations; stellar approximations the closest. April 16, 1880, *P.* xviii, 18–20; also *Comptes Rendus,* 19 Avril and 3 Mai, 1880, *T.* xc. pp. 912, 1061.

118. Cosmical determination of Joule's equivalent; correspondence of centrifugal "lift," indicated by the difference of polar and equatorial temperatures, with the centripetal fall which would give the equatorial velocity of rotation; confirmation of Clarke's discovery, that the molecular volume of chemically combined water is variable, while that of crystal water, or molecularly united water, is invariable. April 16, 1880, *P.* xviii, 20–1.

119. Relations of Chemical Affinity to Luminous and Cosmical Energies; simple ratio of mean molecular velocities in gases, to velocities of terrestrial rotation and revolution; harmonic wave-lengths in Vogel's hydrogen and Paalzow's oxygen-spectra. April 16, 1880, *P.* xviii, 21–5.

Stated Meeting, November 19, 1880.

Present, 16 members.

President, Mr. FRALEY, in the Chair.

A letter of acknowledgment was received from the New York Academy of Sciences, October 23 (68, 75, 76, 79, 80, 89, 97, 102, 104).

A letter of envoy was received from the Royal Dublin Society, dated September, 1880.

Donations for the Library were received from the Mining Department, Melbourne; Academies at St. Petersburg and Berlin; Batavian Society, Harlem; Geographical Society and Revue Politique, Paris; Revista Euscara, Pamplona; Nature, London; Essex Institute, Salem; Professors Brush and Dana, New Haven; Franklin Institute, Historical Society, American Numismatic and Antiquarian Society, Editor of the American, and Mr. Henry Phillips, Jr. Philadelphia; Revista Cientifica and Ministerio de Fomento, Mexico.

The death of Mr. Henry Wharton, November 11, at Philadelphia, aged 53, was announced by Mr. J. S. Price, and, on motion, Mr. Jos. B. Townsend was requested to prepare an obituary notice of the deceased.

The death of Dr. Alexander Wilcocks, November 10, at Philadelphia, aged 62, was announced by Mr. Price.

The death of Prof. John Rudolf von Wagner, at Würtzburg, October 4, aged 58 (born at Leipsig, February 13, 1822), was announced by the Secretary.

Mr. Dubois offered the following from his note-book, in the U. S. Mint:

"November 19, 1880. Professor Baird, of the Smithsonian Institution, brought an engraved disk for examination. It was found in Guatamala, and at first view it seems to be a coin. It is not that, however; the lines and figures being chased with a graving tool, quite too slow an operation for making currency.

"On one side is a wolf, among trees; and on the other a tapir, behind which stands a man. A hole, rudely punched, must have served for hang-

ing the piece around the neck, as an ornament or amulet. There is no attempt at lettering.

"The measures are: Diameter, 1.4 inch; thickness, 75 thous. of an inch; weight, 18¼ grammes; sp. gr. 8.80.

"This last, together with the color and the good preservation, indicate a mixture of copper and tin.

"It bears some testimony to the condition of the aboriginals, and in that view is interesting.

"Mr. Phillips expressed the opinion that the piece was not much more than a century old."

Mr. Lesley exhibited and described three models in plaster:

1. Of the Seven Mountains in Middle Pennsylvania, surveyed by Charles E. Billin.

2. Of the Stone Mountain Fault, by Mr. Charles E. Billin.

3. Of a part of the Middle Anthracite Coal Field, constructed from the first specimen sheet map of the Anthracite Survey, by Mr. Charles A. Ashburner.

The minutes of the last meeting of the Board of Officers and members in council were read, and the following resolutions were adopted:

1. *Resolved*, That the Society has no power to modify the regulations prescribed by the donor (Mr. Magellan) for the awarding of the Magellanic premium.

2. *Resolved*, That the third condition precludes the awarding said premium to any person who has already published his or her discovery in taking out a patent, and who is also rewarded therefor by the monopoly conferred by the letters patent.

3. *Resolved*, That Chapter XII of the By-Laws be printed on the fly-leaf of each number of the Proceedings until further orders.

Four other resolutions recommended for consideration were postponed for the present, one of them involving a change in the By-Laws, and requiring certain preliminary formalities. (See Minute Book.)

Pending nominations Nos. 909, 920, 921, 922, and new nominations Nos. 923, 924, 925, were read, and the meeting was adjourned.

Notes on the Models Exhibited at the Meeting November 19, 1880. *By J. P. Lesley.*

These models were made by and under the superintendence of Mr. Ed. B. Harden, Topographical Assistant of the Second Geological Survey of Pennsylvania, and form part of a collection of models in the Museum of the Survey, No. 907 Walnut street, Philadelphia.

Each is constructed on one and the same vertical and horizontal scale to avoid structural distortion; but the scale of the first is 1 mile: 1″; that of the second 1600′: 1″; and that of the third 800′ : 1″.

The model of the Seven Mountains represents a district of anticlinals and synclinals, forty miles long, extending along the north side of the Kishicoquillas valley in Centre and Union counties. Parallel anticlinal ranges of Medina and Oneida, dying down eastward into Union, and westward into Huntingdon counties, form a mountain belt between the Siluro-Cambrian lowlands of Kishicoquillas valley in Mifflin and Snyder counties in the south, and Pine Creek, Brush and Nittany valleys of Clinton and Centre counties on the north. The broad rounded spurs sinking with the axis of each anticlinal beneath the Clinton red shale and fossil iron ore beds, are finely shown. In the heart of the region the anticlinal mountains split open, and show long narrow deep vales of Hudson river slate, while the synclinals contain long narrow strips of Clinton red shale.

In two places occur diagonal upthrow faults on a large scale, one through the Stone Mountain at Greenwood furnace; the other (in a prolongation of the line of the first fault), some miles further to the north-east.

Both faults have the western portion thrown northward and backward towards the north-east, as in a diagonally splintered arm bone drawn together by the contraction of the muscles; and this structure is plainly exhibited by the termination against each side of each fault of the Medina mountain crest, and of the Oneida terrace which always accompanies it.

The model of the Stone Mountain fault shows the structure on a large scale, and especially the slight curves at the ends of the hypothetical straight line of the fault, as well as the crushed and packed-in condition of the red shales around the north-east end of the fault. In the case of the other fault, there is a much greater complication; for two cross faults, at the two ends of the main slide line, parallel to each other, must be imagined to satisfy all the surface conditions.

The model of the Mammoth bed floor in the Schuylkill county is the first of this kind constructed in the Anthracite region. There is a model of the same kind in the Museum of the Towne School of the University of Pennsylvania, showing the floor of the Pittsburgh coal bed in Somerset county, Pennsylvania, which I had made by my students from data obtained by a special survey ordered by the Board of Commissioners of the Geological Survey in 1875. But the Anthracite basins are deep, steep sided, and with their separating anticlinals sometimes overthrown towards the north and collapsed. These are the most striking features of this model.

It also exhibits for the first time another unexpected and very important

feature, viz: the kettle-shaped isolation of the subordinate synclinals, which ride upon the crests of anticlinals at their ends. In fact, the views which we have hitherto held of the general continuance and parallelism of the sub-basins receives here a rude shock. The greatest irregularity prevails in the arrangement of the mutually interlocking sub-anticlinals and sub-synclinals. At the same time it is most interesting and satisfactory to see that in this respect the dimpled structure of the broad and shallow bituminous basins is reproduced in the narrow and deep anthracite basins.

The crushing, sidewise thrusting action from the south against the Anthracite coal region is admirably illustrated by this model, which is only the first of a series, to be extended lengthwise of the Mahanoy and Shamokin field as the Geological Survey advances.

Stated Meeting, December 3, 1880.

Present, 19 members.

President, Mr. FRALEY, in the Chair.

Letters of envoy were received from the Royal Observatory, Greenwich, Dec. 1880; and the Board of Commissioners of the 2d Geological Survey of Penna., Harrisburg, Nov. 25, 1880.

Donations for the Library were received from the R. Accademia dei Lencei, Rome; Zoologischer Anzeiger, Leipsig; Geographical Society, Annales des Mines, and Revue Politique, Paris; Society of Commercial Geography, Bordeaux; R. Astronomical Society, and Nature, London; American Academy of Medicine, and Editors of the International Review, New York; Academy of Natural Sciences, Medical News, Engineers' Club, Journal of Pharmacy, and Geo. Hamilton, M. D., Phila.; and the Board of Commissioners of the 2d Geological Survey of Pennsylvania.

A letter from Mrs. Haldeman, enquiring about the memoir and relics for illustration by the late Prof. Haldeman was read, and on motion it was

Resolved, That the Curators be authorized to deposit the cards on which these relics are arranged, in the Museum of the Academy of Natural Sciences, and to take a receipt for the same, as in the case of other curiosities belonging to this Society there deposited.

The death of Prof. Jas. C. Watson, at Madison, Wis., Nov. 23, 1880, aged 41, was announced by the Secretary.

A communication entitled: "On the Vertebrata of the Wind River Eocene beds of Wyoming. By E. D. Cope," was read by title.

Dr. König exhibited two specimens of silver ore from near Ouray, in Colorado, of unusual interest as exhibiting the reduced native silver and also the asphalt (enclosed in calcite) by which it had been reduced.

The Treasurer's annual report was read and referred.

The Publication Committee reported verbally that they had approved the plates for Prof. Haldeman's Memoir.

The Committee on the communication x, y, z, for the Magellanic Premium reported; and on motion the following resolutions were passed:

Resolved, firstly, It appearing that the communication of x, y, z, for the Magellanic premium relates to mechanical devices not immediately pertaining to Navigation, Astronomy, or Physics, it is not proper that the question of merit or worthiness of the invention, discovery, or improvement set forth should be passed upon by this Society.

Resolved, secondly, That the Secretaries be authorized and empowered to allow the withdrawal of this communication by any person who, they may become satisfied, has the right to withdraw the same, and that the Secretaries be directed to assure such person that the Society commits itself to no opinion in any way derogatory to the invention, discovery, or improvement, but simply finds the same not to relate to the subjects prescribed by Magellan, or those upon which premiums are to be awarded.

Pending nominations Nos. 909, 920 to 925, and new nomination No. 926 was read.

The resolution offered by Dr. LeConte, at the last meeting, was then considered, and there being present the lawful number of 3 members of the Board and Council, and 13 members of the Society necessary for a change in the By-Laws, after due public notice given, was unanimously adopted.

Resolved, That the concluding clause of the first paragraph on page 17 of the By-Laws, *i. e.*, all after the word "premium" in the 5th line of that page, be struck out, and the words "for such purposes as may be authorized by its charter and laws" be substituted therefor.

The other three resolutions recommended to the consideration of the Society were on request again postponed to allow time for the members of the Society to become better acquainted with their tenor.

1. *Resolved*, That the members of the Society be invited to send to the Secretaries the names of notable discoverers in any branch of science, or the fine or useful arts, with the reasons for bestowal of medals for their discoveries.

2. *Resolved*, That such names and recommendations be placed for consideration in the hands of the President to report to the Society his verdict in favor of one or more of them if proper.

3. *Resolved*, That, in case no veto is placed by the Society on such verdict, there shall be a presentation of medals to the persons recommended by the President at a time and in a manner to be arranged by him.

And the meeting was adjourned.

Stated Meeting, Dec. 17, 1880.

Present, 10 members.

Vice-President, Mr. PRICE, in the Chair.

Mr. J. B. Townsend accepted by letter his appointment to prepare an obituary notice of the late Henry Wharton.

A letter respecting duplicates was received from H. B. Dawson, Morrisania, N. Y.

A circular was received from the Peabody Academy of Science, at Salem, Mass.

Donations for the Library were received from the Asiatic Society of Japan; the Berlin Academy; the Verein für Beförderung des Gewerbfleisses, Berlin; Zoologischer Anzeiger, Leipsig; Naturhistorisches Verein, Bonn; Revue Politique, Paris; Revista Euskara, Pamplona; Nature, the Nautical Almanac Office, and Dr. C. Wm. Siemans, London; R. Dublin Society; Yale College, and the American Journal, New Haven; Franklin Institute, Commissioners of the New Public Buildings, and Mr. Henry Phillips, Jr., Philadelphia; Hon. Lane S. Hart, State Printer, Harrisburg; Johns Hopkins University, Baltimore; U. S. Geo-

logical Survey of the Territories; and the Ministerio de Fomento, Mexico.

Two pieces of slag from the site of the earliest iron furnace in Virginia was presented to the cabinet by Mr. Phillips, for Mr. R. Alonzo Brock.

Prof. Cope was, on motion, permitted to withdraw for immediate publication elsewhere his communication on the Vertebrata of the Wind River Eocene beds, the principal features of which he described, and exhibited the lower jaw of *Bachyopsis hiscidens* in illustration of the extraordinary character of these fossils. Of 46 species studied, 26 species (and 3 genera) are new. The collection is specially important as placing the Wind River beds (hypothetically) between the Bridger beds above and the Wasatch beds below, types peculiar to each being found mingled in it.

Mr. Lesley read extracts from a letter from Mr. Andrew S. McCreath, Chemist in charge of the State Geological Labratory at Harrisburg, giving an analysis of a *pure* dolomite exposure, in mass, in Franklin county.

HARRISBURG, Dec. 10, 1880.

"While selecting samples of the iron ores in the Mt. Alto district, Col. Wiestling showed me a limestone quarry or opening which, on one of your visits, you thought was partly unaltered blue carbonate of iron, with possibly 18 to 20 per cent. metallic iron. Samples were carefully selected—201 pieces for sample—and analysed with the following results:

Carbonate of lime	51.743	
Carbonate of magnesia	43.436	
Carbonate of iron	.665	= 0.321 % iron.
Alumina	.222	
Sulphate of lime	.046	
Phosphate of lime	.065	
Silica	4.090	
	100.267	

"Calculating the carbonates of lime and magnesia to 100 parts we get the following as compared with a true lithological dolomite:

	Shiery Quarry, Mt. Alto.	Dolomite.
Carbonate of lime	54.36	54.35
Carbonate of magnesia	45.64	45.65
	100.00	100.00

"I find this extremely interesting, for it is the only *true* dolomite I have yet found in such large quantity in this State."

Also notes by Prof. I. C. White, Asst. Geologist and Professor of Natural History in the University of West Virginia, stating his conclusions respecting the distribution of the members of the Conglomerate in Western Pennsylvania.

Mr. Lesley exhibited an index guage which he had had constructed by Messrs. Young, of Philadelphia, for the use of the Survey, and showed a small topographical model in wax which had been made by means of it.

The Treasurer read the report of the Committee on Finance.

On motion, the appropriations recommended by the Committee were passed.

The report of the Trustees of the Building Fund was read by the Treasurer.

On motion of Mr. Lesley, the Committee on Publication was authorized to issue the articles published in the Transactions, separately, or together, at their discretion.

And the meeting was adjourned.

Notes on the Place of the Sharon Conglomerate in the Palæozoic Series. By Prof. I. C. White.

(*Read before the American Philosophical Society, Dec.* 17, 1880.)

With regard to the place of this rock in the series, about which there has been much diversity of opinion among geologists, I have to say that my study of it and its associated rocks during the past season in this district,* as well as in Venango and Warren counties, to the east, and in the State of Ohio to the west, has dispelled the idea that I at one time entertained of the possibility of its being the Vespertine Conglomerate, or No. X of Rogers, and has confirmed me in the position that I took in my reports Q and QQ on Beaver and Lawrence counties, viz : that it is the true base of No. XII.

It may be of interest to state here the reasons which caused me to entertain such a possibility.

It happened that during my season's work in Mercer county in '78, I discovered a new limestone in the Mahoming river, only about 50′ above the horizon of the Sharon Conglomerate, and nearly 100′ below any limestone hitherto known in Western Pennsylvania. It was filled with fossils and some of them seemed to be related to Subcarboniferous types.

* These notes were written for the Report of Progress of the Survey in Erie and Crawford counties. J. P. L.

By a singular fatality, it also happened that the supplemental Report of Prof. Orton on the Hanging Rock district of Southern Ohio came into my hands at about the same time.

It is well known that in the Report in question Prof. Orton takes the ground (in which he was also sustained by the Chief Geologist, Prof. Newberry), that the *Jackson shaft coal* of that State is of *Subcarboniferous age*, since, as he maintained, its place comes below the horizon of the Maxville (Cheater) Limestone of Andrews, and as the *Maxville* was placed in the section about 100′ above the *Jackson shaft coal*, I supposed there could be no doubt about it.

I also knew that wherever the Jackson shaft seam was placed, the *Sharon* must go with it, since the general stratigraphy, the flora connected with each, and everything else found in connection with them go to prove that they are identical.

Then the fact that Prof. Orton placed the *Maxville Limestone* the same distance below the *Zoar Limestone* (= our Lower Mercer) that I had found the *new limestone* below our *Lower Mercer*, strengthened the supposition that it might be synchronous at least with the Maxville.

And in order to bring out these new facts, I prepared a special chapter for my Report on Mercer county, QQQ, entitled "The Place of the Sharon Coal in the Rock Series," in which the facts were given that seemed to favor the view that the *Sharon Coal* was of *Subcarboniferous age*, and the Conglomerate below it, *Vespertine*.

Before the volume was published, however, I had studied the matter still farther in the Crawford and Erie district, as well as elsewhere, and as before stated, saw reasons for the giving up the probability of its Subcarboniferous age. I accordingly requested Prof. Lesley to suppress the chapter in question, as its publication at that time would have done more harm than good. Hence QQQ was allowed to leave the press with Chap. VII stricken out. In the meantime Prof. Orton has written me that he will have to give up the position that he took in Vol. III, of the Ohio survey with regard to the *Subcarboniferous age* of the *Jackson shaft coal*, and with that abandoned there remains so little evidence that the *Sharon coal* is *Subcarboniferous*, that for the present it is not worth serious consideration.

The foregoing explanation is relevant in this connection because of the currency given in Prof. Lesley's preface to QQ, to the views expressed in the afterwards discarded Chapter VII, of QQQ.

But while it thus appears that the *Sharon Conglomerate* is the true base of the Carboniferous epoch proper, it must also be remembered that like the *Sharon coal* resting on its top, it seems to have been a deposit peculiar to the *northern rim* of the Coal measures, everywhere skirting them around the north, but seldom passing far south under them, so that although toward the north the succession is definite enough, and it is plainly seen that the *Subcarboniferous rocks* end with the base of this stratum, yet toward the south in the absence of this rock the Subcarboniferous beds, with their fossils, extend

up to the base of the *Sharon coal*, and in the absence of that deposit, also extend to the very base of the *Lower Connoquenessing Sandstone* which then becomes the base of the *Conglomerate series*.

Thus it is that in passing south along the Shenango and Mahoming rivers into Lawrence county, the *Cuyahoga shale*, and its fossils, are found coming up to the base of the Lower Connoquenessing Sandstone.

It follows from this northward distribution of the Sharon Conglomerate, that the marine conditions that had so widely prevailed during the closing period of the Subcarboniferous epoch, so far as Western Pennsylvania is concerned, came to an end sooner around the northern margin of the present coal field than elsewhere, that to the south, marine conditions continued to prevail, while on the northern beaches, brought above or near sea-level either by greater rising or less rapid subsidence, the Sharon Conglomerate commenced to accumulate, and continued to do so during the long time that marine conditions still obtained to the southward; finally however the incursion of the coarse sediments of the *Connoquenessing Sandstone* destroyed the life in the shallow seas southward, and so far as we know this put an end to Subcarboniferous life and conditions in Western Pennsylvania, that had already been forced a considerable distance southward by the incursion of the disturbing currents which carried the coarse material of the Sharon Conglomerate. It may even have happened that still farther south along the Chestnut Ridge region where subsidence was greater, that the marine conditions of the Subcarboniferous epoch continued to exist until the great incursion of coarse sediment which formed the *Homewood Sandstone* and completed the *Conglomerate series*, and this indeed seems in some regions to have actually been the state of affairs since in Fayette and Westmoreland counties, Pa., and in the adjoining county of Monongalia, W. Va., the only member of the series present in any force is the Upper, or *Homewood*, and it is 175′–200′ thick. There is nothing at all to represent the *Sharon Conglomerate* of the north, and the interval between the *Umbral Limestone* and the *Homewood Sandstone* is made up of reddish and greenish shales interstratified with green sandstones which look more like *Subcarboniferous rocks* than any representatives of No. XII that I have ever seen. And in fact at times this Homewood Sandstone itself appears absent or in little force, and then the red shales of the Umbral continue up to the very base of the *Lower Productive Coal measures*.'

Hence, if am correct in this interpretation of facts, it will not do to draw a hard and fast line at any place in the series and say that every thing *above* it is *Carboniferous* and everything below *Subcarboniferous*; for as well as we can unravel the history in Western Pennsylvania, it would seem that the Sharon Conglomerate at least, was in process of formation and synchronous with marine conditions prevailing farther south, essentially similar to what had existed at the north previous to the change in conditions which rendered the accumulation of that mass of coarse sediment possible, and that subsequently the changed conditions at the north were carried farther and farther south with each great incursion of coarse material until

finally the period culminated and ended by the spread of the Homewood Limestone as an almost universal covering over Western Pennsylvania.

After this final castastrophe scarcely any of the life forms that had existed before the accumulation of the Sharon Conglomerate remained, though the process of extinction and change had been progressive toward the south from the beginning.

On this theory only, so far as I can see, can we explain the results at which Mr. Platt of the Survey Corps seems to have arrived from the study of the rocks to the south-east in Jefferson, Indiana and Armstrong counties, viz: that the rocks of No. XI (Subcarboniferous) extend up to the base of the *Homewood Sandstone*, and that *it* is the only member that can be properly placed in No. XII.

In such localities where Subcarboniferous conditions seem to have existed until the epoch of the Homewood Sandstone, or top member of the Conglomerate series, it would certainly be unwise to include any lower beds in this series, and yet it seems to me equally wrong to draw the line along the base of the *Homewood Sandstone* in such a case and extending it over wide areas, call everything below it Subcarboniferous.

It is a question of time against conditions. If it be right to call all rocks *Subcarboniferous* that were formed everywhere and under any surroundings until Subcarboniferous conditions had closed everywhere then it would undoubtedly be correct to draw the line squarely at the base of the Homewood Sandstone; but under the broader view that discards cataclysmal changes in the Earth's history, and recognizes the now well proven fact that almost all great changes have been gradual and progressive, and that to be so they must have had a beginning somewhere in the midst of widely differing conditions, recognizing this principle it seems to me there should be no hesitation about extending the line downward from the base of the Homewood Sandstone, as we proceed north, under the feather edges of these northern Conglomerates, until we reach the base of the Sharon Conglomerate, even if this latter stratum were coëtaneous with the deep sea that prevailed along the south line of Western Pennsylvania during the Chester limestone epoch, for all these conglomeratic sandstones from the base of the Sharon to the top of the Homewood, were formed under similar conditions, and the Subcarboniferous sea at no time returned northward to restore the life forms which the appearance of the Sharon Conglomerate had driven away forever. To do otherwise than this would be equivalent to classifying the marine deposits which are now taking place along the coasts of this country and Europe with the Cretaceous, because perchance Cretaceous life and conditions may now exist in the deep bed of the Atlantic.

I have discussed this matter somewhat at length, hoping to throw some light upon and help to harmonize the hitherto conflicting results of all who have undertaken the study of this question. It is certainly a difficult subject to deal with, but it seems to me that we have now got hold of some of the threads at least, out of which the true history of the fabric can be woven.

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Mr. Lesley said, in presenting these notes, that he considered every field geologist entitled to the expression of his opinions, but that only such as worked over the whole field, and knew precisely all the facts in every part of it, would be likely to see a clear way to the final resolution of its difficulties. These difficulties cannot be resolved on the Ohio side of the coal field alone; nor on the Alleghany Mountain side of it alone; nor by even an exhaustive observation in the north, nor by an exhaustive discussion of them in the south. If there *be* "a northern rim" to the ancient coal field, there must have been an eastern and a southern and a western one also; and no generalization will avail that does not satisfy the data all around the compass—and in fine, also, all over the interior area, where unfortunately we have very few opportunities for study.

These difficulties are set forth in the preface to Mr. Platt's report H 5 on Armstrong county, in which the same suggestion of an overlapping of the upper divisions of No. XII is made which Prof. White makes in these notes. But it is there shown that the exhibition of No. XII along the Alleghany mountain, and in Maryland and Virginia, as well as in the northern counties, and in the Anthracite coal region of our own State, is not such as can be entirely explained by the suggestion; which has its value; but which must be cautiously followed as a guide in classification.

The combined labors of half a dozen geologists, all equally competent as observers and theorizers—labors pursued unremittingly now for half a dozen years—have not yet sufficed to procure all the light we need to have thrown on the synchronomy of even our own Pennsylvanian Carboniferous and Devonian deposits; and every fresh survey in a new district like that of Mr. Jones in Maryland, and that of Prof. Stevenson in Southwest Virginia, serves, among other things, to throw doubt upon the shifting generalizations in which too many otherwise judicious geologists are prone to indulge—reversing the directions in which we look for the

original sources and maxima of deposits—shortening the radii of areas of violent variations, and even of nonconformability—and embarrassing the best laid plans for restoring the state of things in ancient days.

Photodynamics. By Pliny Earle Chase, LL.D.

(*Read before the American Philosophical Society, Jan. 7, 1881.*)

The general laws of motion have been largely studied in connection with the special departments of Thermodynamics and Electrodynamics. Little attention has been paid, comparatively speaking, to the much broader field of Photodynamics.

Sir John Herschel showed* that the elastic force of the air, in its resistance to compression, would require to be increased, "*in proportion to the inertia of its molecules,*" more than 1,000,000,000,000 fold to admit of the propagation of a wave with the velocity of light, and that this enormous physical force is perpetually exerted at every point, through all the immensity of space. He also said†: "It must be remembered that it is LIGHT, *and the free communication of it from the remotest region of the universe,* which alone can give and does give us the assurance of a uniform and all pervading energy." We have no equally positive evidence of the direct transmission of heat and electricity from the heavenly bodies, and inasmuch as all thermal and electrical phenomena can be explained by local transformations of simple radiant energy, the philosophical basis of Photodynamics appears to be better grounded than that of either Thermodynamics or Electrodynamics.

In 1863, I began a series of general kinetic investigations, in confirmation of views which may be expressed by the following general postulate: *All physical phenomena are due to an Omnipresent Power, acting in ways which may be represented by harmonic or cyclical undulations in an elastic medium.* In my first paper‡ I showed the importance of the fundamental equations $v = \frac{gt}{2}$; $h = \frac{gt^2}{4}$ = the *modulus* of v; in which t represents the time of cosmical, molecular, or atomic rotation, and g represents the acceleration of a central force.

By combining these equations with considerations derived from the equality of elastic actions and reactions proportioned to mass, and from tendencies to conservation of areas, I found that the daily and annual fluctuations of the barometer furnish harmonic indications of Sun's mass and distance, and I announced my confident expectation of other astronomical

* Familiar Lectures on Scientific Subjects, pp. 281-3

† Ib. p. 218.

‡ Proc. Am. Phil. Soc., vol. ix, pp. 283-8.

verifications or rectifications by means of varying pressures.* In the following year I introduced the hypothesis, which has since been largely developed by Edlund, that electricity consists simply of æthereal vibrations.† In confirmation of this hypothesis, I showed that many of the phenomena of terrestrial magnetism can be produced by simple mechanical vibrations, resembling those of the atmospheric currents which arise from the combined action of terrestrial rotation and thermal convection.‡ In connection with these investigations I called attention to the importance, and some of the probable consequences, of radial and tangential oscillations *moving with the rapidity of light*,§ and of their bearing upon "the phenomena of light, heat, electricity, polarity, aggregation, diffusion, meteorological changes, seismic tremors, crystallization, stratification, chemical action and general morphology."‖

My discovery of numerous numerical relations between gravity and magnetism, for which the American Philosophical Society awarded its Magellanic medal, led me to seek, in the maximum manifestations of gravitating force, the correlation of gravity with other forms of energy, for which Faraday** had looked confidently but in vain. The greatest gravitating force in our system and, therefore, the greatest of which we have any direct and positive evidence, is at Sun's surface, where material particles are subjected to such oscillations as may arise from the conflicting centripetal energies of solar attraction and of the resultant attraction of all other cosmical bodies. In applying the fundamental equation, $v = \frac{gt}{2}$, at Sun's surface or the locus of maximum gravitation, I found that the equality of action and reaction, as shown by the sum of the solar-central gravitating reactions against the sum of the gravitating actions towards the centre of the solar system, in the cyclically alternating thrusts and pulls of half-rotation, *is represented by the velocity of light.*†† This discovery, together with the identification of the same velocity as a factor of electro-magnetic action, which was completed and confirmed by the investigations of Thomson and Maxwell, brought all physical phenomena, cosmical as well as molecular, within the domain of Photodynamics.

The molecular phenomena may be readily connected with the cosmical, through the correspondence between Challis's laws of molecular action and the laws of attraction and rotation.‡‡ They furnish grounds for estimating Sun's mass and distance by means of the explosive energy of hydrogen ;§§ for discovering some of the subordinate elements of planetary arrange-

* Ib. ix, 288; x, 376.
† Ib. ix, 355-60.
‡ Ib. ix, 367-71, 425-40, 487-95; x, 97-118, 151-66.
§ Ib. ix, 407-11.
‖ Ib. ix, 439.
** Exp. Res., 2614.
†† Proc. Am. Phil. Soc., xi, 103-7.
‡‡ Ib. ix, 367-71.
§§ Ib. xii, 392-4.

ment ;* for a mathematical deduction of the ratio (1.4232) between the mean *vis viva* of gaseous volume (*heat under constant volume*) and the *vis viva* of uniform velocity (*heat under constant pressure*) ;† for finding an identity of law in luminous and planetary nodes ;‡ for a cosmical determination of Joule's equivalent ;§ and for connecting the molecular velocities of gaseous particles with the velocities of terrestrial rotation and revolution.‖

Although many of the stellar motions indicate the probability of gravitating action, in other systems than our own and between different systems, no direct, positive and measurable evidence of such action has yet been found. Gravitating and elastic forces may, however, be numerically compared, through the common equation of wave and orbital velocity, $v = \sqrt{2gh}$, in which h represents the height of virtual fall which would give the required velocity, or $\frac{1}{2}$ the height of a homogeneous atmosphere, or $\frac{1}{2}$ the radius of a circular orbit, or the focal distance in a parabolic orbit. In consequence of the tendency of nodal points, in any vibrating elastic medium, to produce harmonic vibrations and harmonic nodes of various kinds, we may reasonably look for such nodes as results and evidences of interstellar action.

Among the various gravitating, paraboloidal and harmonic wave influences, which have been instrumental in world building, the following seem specially noteworthy :

α. The principal centre of nucleation in the solar system, which is represented by the Sun.

β. The principal centre of condensation, which is represented by the Earth ; Mercury's secular perihelion being .2974,¶ and the secular aphelion of Mars being 1.73648, the middle of the dense belt of planets is 1.01694, which is midway between Earth's mean distance and mean aphelion (1.03387).

γ. The principal nebular centre of the system, which is represented by Jupiter's mean aphelion ; Neptune, the aphelion planet, being 30.03386, and Uranus, its corresponding perihelion planet, being 19.18358, the nebular centre is 5.42514. Jupiter's mean aphelion is 5.42735.

δ. The linear centre of oscillation of a solar diameter ($\frac{2}{5}$), which gives $\frac{1}{5}$ radius as a directrix of paraboloidal influence, and $\frac{1}{6}$ radius as the abscissa of the paraboloidal vertex.

ε. The ratio $(\frac{1}{3})^2$, between the solar central force at the paraboloidal vertex and the corresponding force at Sun's equatorial surface.

ζ. The ratio of dissociative subsidence $\left(\frac{nr}{n+1}\right)$. If we take the radius of a nebula as a fundamental node, the velocity which would be acquired

* Ib. xii, 403, seq.
† Ib. xiv, 651.
‡ Ib. xvii, 109-12.
§ Ib. xviii, 20-1.
‖ Ib. xviii, 21-5.
¶ The values are taken from Stockwell, *Smithsonian Contributions*, 282.

by a body in falling from a distance nr to any other distance x may be found by the equation, $vdv = gr^2x^{-2}d\ (nr-x)$; integrating and reducing, $v = \left\{\frac{2\,gr\,(nr-x)}{nx}\right\}^{\frac{1}{2}}$. If this velocity is due to a synchronism of activity, between nebular condensation within any given stellar system and parabolic projection between different systems, $v = \sqrt{2gr}$; $\frac{nr-x}{nx} = 1$; $x = \frac{nr}{n+1}$.

η. If $n = 2$, $\frac{n}{n+1} = \frac{2}{3}$. This corresponds with the centre of linear oscillation; it is also the locus of belt formation, on account of the collision of subsiding particles from opposite extremities of a nebular diameter. In such subsidence there would be a tendency to form confocal elliptic orbits,* with major axes of $\frac{3r}{2}$ and minor axes of $r\sqrt{2}$.

θ. In rupturing or explosive oscillation, the *vis viva* of wave propagation is $\frac{8}{9}$ of the *vis viva* of oscillating particles.† This relation was subsequently pointed out by Maxwell,‡ apparently without being aware that I had called attention to it five years previously.

I. Harmonic nodes with the ratio $\frac{1}{9}$, (ε), indicate the primary division of the solar system, as may be seen by the following comparisons, in which r_0 represents Sun's radius:

Theoretical.		Observed.	
$9^2\ r_0 =$	$81\ r_0$	Mercury	$83.05\ r_0$
$9^3\ r_0 =$	$729\ r_0$	Asteroid 76	$731.37\ r_0$
$9^4\ r_0 =$	$6551\ r_0$	Neptune, s. a.§	$6536.91\ r_0$

II. The influence of subsidence (η), at the outer surfaces of the two primitive belts, is shown as follows:

Theoretical.		Observed.	
$\frac{2}{3}$ Neptune =	20.0226	Uranus, m. a.,	20.0442
$\frac{2}{3}$ Mars =	1.0158	Earth, m. a.,	1.0339

We have already seen, (β), that the middle of the belt of greatest condensation is 1.0169.

III. The influence of rupturing oscillation, (θ), at the inner surfaces of the two primitive belts, is equally evident.

Theoretical.		Observed.	
$\frac{2}{3}$ Mercury =	.696778	Venus, m. p.,	.696779
$\frac{2}{3}$ Jupiter =	9.3650	Saturn	9.5389

The oscillating limits of all portions of the Jupiter belt are within the Saturnian belt.

* Proc. Am. Phil. Soc., xvii, 98-109.
† Ib. xii, 392-4.
‡ See Phil. Mag., June, 1877, p. 453.
§ s., *secular*; a., *aphelion*; m., *mean*; p., *perhelion*.

IV. The influence of paraboloidal directrices and vertices, (δ), is manifested in each of the primitive belts :

$\frac{1}{6}$ Mars	= .2894	Mercury s. p.	.2974
$\frac{1}{6}$ Neptune	= 5.0068	Jupiter m. p.	4.9782
$\frac{1}{3}$ Neptune	= 10.01128	Saturn m. a.	10.00006

The paraboloidal vertex for the whole Neptunian belt is within the Jupiter belt.

V. By introducing Laplace's limit of possible solar atmosphere* ($L = 36.36r_0$), and the ratio, $\left(\frac{\pi}{\sqrt{2}}\right)$, of the fundamental velocity $\left(\frac{gt}{2}\right)$ to the corresponding parabolic velocity $\left(\frac{gt}{\pi\sqrt{2}}\right)$, we find the following simple equation of solar and planetary harmonic action at the centre of principal condensation. $\left(\frac{1 \text{ year}}{1 \text{ day}} \times \frac{\text{Sun's semi-diameter}}{\text{Earth's semi-axis major}}\right)^3 = \frac{\pi^2}{2}$. This gives Earth's semi-axis-major $= 214.54r_0$.

VI. The combined influence of centres of nucleation, (α), and of nebulosity, (β), at the centre of condensation, (γ), leads to the following simple harmonic estimate of Sun's mass and distance.

Earth's semi-axis major being $214.54r_0$, the leverage of the paraboloidal directrix is $(214.54 + \frac{1}{3} =) 214.87r_0$, and the mean leverage of Jupiter is $(5.202798 - 1) \times 214.54r_0 = 901.668283r_0$. Multiplying by the respective masses, we obtain, for the ratio of Sun's comparative disturbing force at the directrix and at the centre of condensation, $\frac{1047.879 \times 214.87}{1 \times 901.668283} = 249.712$. The superficial nodal force (ε) being $\frac{1}{9}$ as great, we find, for the ratio of Sun's to Earth's superficial gravity, $\frac{g_0}{g_1} = \frac{249.712}{9} = 27.716$. If we designate superficial gravity by g, volume by V, density by d, and mass by m, it is evident that $r \propto (g \div d)$; $V \propto (g \div d)^3$; $m \propto (g^3 \div d^2)$; $d \propto (g \div r)$. Hence we readily get $\frac{d_0}{d_1} = .25523$; $\frac{m_0}{m_1} = \left(\frac{27.716}{.25523}\right)^3 = 327{,}897$; $\frac{r_0}{r_1} = \frac{27.716}{.25523} = 108.71$; Earth's semi-axis major $= 214.54r_0 = 214.54 \times 108.71 \times 3962.8$ miles $= 92{,}422{,}000$ miles.

VII. The solar modulus of light, ($M = 688.82^2r_0$), furnishes the third element of the parabolic projection which is indicated by the fundamental equation $v = \frac{gt}{2}$. The three elements are all photodynamic, viz: 1. The locus (r_0) of luminous action which makes $\frac{gt}{2}$ equivalent to the velocity of light; 2. The locus (L) of orbital half-revolution which is synchronous with solar half-rotation, the synchronic time being determined by the velocity of light; 3. The locus (M) of radial luminous progression during the same synchronic time of solar half-rotation; M is also the altitude, in

* *Mec. Cel.*, III, § 47.

the fundamental equation $h = \frac{gt^2}{4}$, of Sun's homogeneous æthereal, or light-propagating atmosphere. The values of L and M are found as follows:

The mean time of light-propagation from Sun to Earth being 497.827 seconds, the velocity of light $\left(v_\lambda\right)$ is $214.54r_0 \div 497.827 = .43095r_0$; $v_0 = \sqrt{g_0 r_0} = \frac{2\pi \times 214\ 54^{\frac{3}{2}}}{365.256 \times 86400} = .00062565r_0$; $g_0 = v_0^2 \div r_0 = .00000039144r_0$; $\frac{t}{2} = v_\lambda \div g_0 = 1100965$ sec.; $L = 214.54r_0 \div \left(\frac{\text{half-year}}{1100965 \text{ sec.}}\right)^{\frac{2}{3}} = 36.36r_0$; $M = \left(\frac{v_\lambda}{v_0}\right)^2 r_0 = 474460r_0$.

VIII. By introducing the ratio of dissociative subsidence, (ζ), with the general equation $x_n = \xi\eta^n\zeta^{n^2}$, we find a series of paraboloidal abscissas which complete the photodynamic demonstration of a harmonic nodal action, uniting the solar, planetary and stellar systems. Take for the middle abscissa, $\frac{1}{8}$L, and for the limiting abscissas of centripetal action, $\frac{1}{8}r_0$ and $LM \div r_0$. The relative *vis viva*, or the locus of projection against uniform resistance, of the linear centre of oscillation of L, is $\frac{1}{8}$L; $\frac{1}{8}r_0$ is the paraboloidal vertex; $LM \div r_0$ bears the same ratio to M as L to r_0. If we take 18 successive abscissas on each side of the middle abscissa, the logarithms of η and ζ can be readily found by the equation:

$$\text{Log. } \xi = \text{log. } \tfrac{1}{8} = -.778151.$$
$$\text{Log. } \xi + 19 \text{ log. } \eta + 361 \text{ log. } \zeta = \text{log. } \tfrac{1}{8}\text{L} = 1.208452.$$
$$\text{Log. } \xi + 38 \text{ log. } \eta + 1444 \text{ log. } \zeta = \text{log. LM} = 7.236836.$$

Of these 39 abscissas, 9 are between the vertex and $\frac{1}{2}r_0$, the locus of solar dissociative subsidence (ζ); 9 are between $\frac{1}{2}r_0$ and L; 9 are between L and the locus of reciprocal action, which will be presently explained; 9 are between the reciprocal locus and $LM \div r_0$.

The 40th abscissa is $46353000r_0$ (log. 46353000 = 7.666079). This is in the region of the fixed stars, and at the probable locus of *α Centauri*, the four most recent estimates of its distance ranging between $45340000r_0$ and $48479500r_0$. Both in the centripetal and centrifugal branches of paraboloidal action, 12 of the abscissas are between Sun's centre and surface; 9 are between Sun's surface and the planetary region; 9 are in the planetary region; 9 are between the planetary region and *α Centauri*.

Dividing the planetary abscissas by 214.54, in order to reduce them to terms of Earth's semi-axis major, we find the following accordances:

n.	Centripetal abscissas.	Planetary loci.		n.	Centrifugal abscissas.	Planetary loci.	
21	.2095	$\frac{1}{8}$ Mercury	.1985	—21	.2494	Mercury s. p.	.2974
22	.3632	$\frac{1}{4}$ Venus	.3617	—22	.4362	Mercury m. a.	.4555
23	.6459	$\frac{3}{8}$ Earth m. p.	.6441	—23	.7820	Venus s. a.	.7744
24	1.1788	$\frac{1}{2}$ Mars	1.1424	—24	1.4392	Mars m. p.	1.4032
25	2.2080	$\frac{5}{8}$ Asteroid 55	2.2080	—25	2.7179	Asteroid 45	2.7200
26	4.2432	$\frac{3}{4}$ Jupiter	4.3357	—26	5.2666	Jupiter	5.2028
27	8.3673	$\frac{7}{8}$ Saturn	8.1762	—27	10.4720	Saturn s. a.	10.3433
28	16.9309	$\frac{1}{4}$ Uranus	16.7857	—28	21.3662	Uranus s. a.	20.6792
29	35.1523	$\frac{7}{8}$ Neptune	35.0395	—29	44.7322	$\frac{3}{8}$ Neptune m.p.	44.5985

Both in the centripetal and in the centrifugal abscissas, Neptune indicates a reciprocal action, as if from a joint solar and stellar tendency, the solar preponderating. The centripetal co-efficient ($\frac{7}{8}$) is reciprocal to that of Saturn ($\frac{8}{7}$), Saturn's orbit embracing the primitive centre of rotating inertia for the planetary portion of the nebula ;* the centrifugal co-efficient ($\frac{8}{9}$) is the reciprocal of Earth's centripetal co-efficient ($\frac{9}{8}$).†

All the centripetal abscissas represent loci of nebular subsidence, (ζ), which would communicate velocities equivalent to the corresponding solar-stellar parabolic velocities.

All the centripetal abscissas, except Earth's, correspond most nearly with mean planetary loci ; Earth's abscissa represents mean perihelion, or the mean locus of maximum velocity, which is also the locus of belt formation (η) in a nebula extending to Earth's mean perihelion distance. This may account for the number and simplicity of the harmonic relations which I have pointed out, between Sun's mass and distance and barometric pressure, heat distribution, terrestrial magnetism, thermodynamic *vis viva*, terrestrial gravitation, æthereal and atmospheric inertia, specific gravities, explosive energies, terrestrial rotation, lunar distance, lunar revolution, planetary eccentricities, cosmical masses, nebular condensation, dissociation and aggregation, spectral lines, thermal equivalence, atomicity, chemical affinity, velocity of sound, and velocity of light.

Since these results are derived from the hypothesis of equal gravitating and æthereal action and reaction, we may infer that the density of the luminiferous æther, at Sun's surface, is $\left(\frac{r_0}{M}\right)^3$ of the Sun's density, or $\left(\frac{5.5 \times .25535}{474460^3} \times \frac{773}{.0693} =\right) \frac{1}{6821000000000}$ of the density of hydrogen.

* Proc. Am. Phil. Soc. xii, 405; xviii, 431.
† See also Ib. xviii, 231.

above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve councilors and other officers of the Society, and having received their report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given, by public advertisement) proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention, or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then depending, or who hath not previously declared to the Society, that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment, or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the So-

ciety, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object, or subject matter of the communications, so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure, in any year, of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accummulation of premiums shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of——— A. D. ———" And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for the addition, to the said premium, of such amount as the Society may from time to time think suitable, or for the institution of other premiums.

The treasurer shall, at the first stated meeting of the Society in the month of December annually, make a report of the state of said fund and of the investment thereof.